NOTE TO USERS

Ranking hospitals according to acute myocardial infarction mortality: Do the methods matter?

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March 2004

A thesis submitted to McGill University
in partial fulfilment of the requirements of the degree of
PhD (Epidemiology)

Your file Votre référence
ISBN: 0-612-98295-5
Our file Notre référence
ISBN: 0-612-98295-5

For my parents, Chantal and Toni,
whose endless support and encouragement made this endeavour a reality.

Table of Contents

Table of Tables

Table of Figures

Abstract

Background:

Hospital performance indicators serve as a mechanism for making health care providers accountable to their patients. One indicator adopted by several jurisdictions is hospital mortality rates among patients with acute myocardial infarction (AMI). Despite potentially serious repercussions poor results can have on how a hospital is judged, there remains considerable variation in the methods used to measure and compare this indicator. The purpose of this study is to estimate the extent to which methods used to define AMI mortality outcomes and to deal with transferred AMI patients impact on hospital performance ratings.

Methods:

Using Quebec's Med-Écho hospital discharge records and vital statistics for 91,633 AMI patients admitted between 1992 and 1999, hospital rankings were compared using three methods to define AMI mortality outcome (in-hospital death, death within 7 days of admission, and death within 30 days of admission) and using three methods to handle transfers (excluding all transfers, including transfers while assigning the outcome to the initial hospital, and including transfers while assigning the outcome to the receiving hospital).

Findings:

There was discordance in hospital quintile classification 34% to 43% of the time when using pairwise comparisons of outcomes, and 23% to 32% of the time when using pairwise comparisons of ways to deal with transfers. Using hospital ranks to identify significant outliers as a method for evaluating hospitals, 5 hospitals were identified as "best performers" at least once, whereas 11 hospitals were identified "worst performers" at least once. One hospital was among the "worst performers" regardless of which among the six hierarchical analyses was used, while another was among the "best" using all but one analysis. The absolute difference in

significantly high or low hospital mortality rates exceeded the clinically relevant benchmark of 1%.

Conclusions:

The methods used to define AMI mortality outcome, or to deal with transfers had an impact on which hospitals were identified as "outliers". Hospital reputations can be damaged by such findings. Furthermore, although this study was limited to comparing the impact on rankings based on AMI hospital mortality rates, other indicators of hospital performance may be influenced to a greater degree based on the methods used to deal with transferred patients.

Abrégé

Contexte :

Les indicateurs de performance hospitalière servent de mécanisme de contrôle auprès des pourvoyeurs de soins de santé, tenus responsables vis-à-vis de leurs patients. Un des indicateurs, adopté par plusieurs instances, est celui du taux de mortalité hospitalière chez les patients atteints d'un infarctus du myocarde aigu. Malgré les répercussions sérieuses que peuvent avoir des résultats médiocres sur la réputation d'un hôpital, il y a une variation considérable parmi les méthodes employées pour mesurer et comparer cet indicateur. Cette étude cherche à évaluer l'impact des méthodes utilisées, pour définir la mortalité ou les critères d'inclusion relatifs aux patients transférés, sur les résultats d'une évaluation de la performance comparative des hôpitaux.

Méthodes :

En utilisant la base de données des hospitalisations au Québec, Med-Écho, et les statistiques démographiques de 91,633 patients admis à l'hôpital avec un infarctus du myocarde aigu entre 1992 et 1999, la performance des hôpitaux a été comparée selon trois méthodes différentes pour définir la mortalité hospitalière et selon trois critères différents d'inclusion relatifs aux patients transférés. Les trois méthodes utilisées pour définir la mortalité hospitalière sont : les décès intra-hospitaliers; les décès dans les 7 jours qui suivent la date d'admission; et les décès dans les 30 jours qui suivent la date d'admission. Les trois critères d'inclusion relatifs au patients transférés qui ont été utilisés sont : l'exclusion de tous les transferts; l'inclusion des transferts avec assignation des résultats selon l'hôpital expéditeur; l'inclusion des transferts avec assignation des résultats selon l'hôpital receveur.

Résultats :

Le taux de désaccord dans la classification quintile des hôpitaux est de 34% à 43% lorsque deux méthodes différentes pour définir la mortalité hospitalière sont comparées à la fois; alors que ce taux de désacord est

de 23% à 32% lorsque deux critères différents d'inclusion relatifs aux patients transférés sont comparés à la fois. En examinant les rangs pour identifier les taux de mortalités hospitalières exceptionnels, 5 hôpitaux ont été désignés comme les plus performants (ayant les taux les plus bas) au moins une fois, alors que 11 hôpitaux ont été désignés comme les moins performants (ayant les taux les plus élevés) au moins une fois. Un hôpital a été classé parmi les moins performants, quelle que soit l'analyse utilisée, alors qu'un autre hôpital a été classé parmi les plus performants en utilisant 5 des six analyses. Les différences significatives entre les taux de mortalité exceptionnels et le taux global dépassent le point de référence de 1%, dit cliniquement pertinent.

Conclusions :

Les méthodes différentes pour définir la mortalité hospitalière et les critères différents d'inclusion relatifs aux patients transférés qui ont été comparés dans cette étude eurent un impact considérable sur les résultats d'évaluation de la performance comparative des hôpitaux. Ces résultats risquent fort d'endommager la réputation des hôpitaux. Bien que cette étude se limitait à évaluer l'impact des méthodes utilisées pour comparer les rangs hospitaliers selon le taux de mortalité, d'autres indicateurs de la performance hospitalière pourraient être influencés davantage par les critères d'inclusion retenus, relatifs aux patients transférés.

Preface to Thesis

The idea for this thesis came from my longstanding interest in the area of quality improvement in health care. This interest in quality improvement evolved throughout my career, beginning with a clinical perspective of a health care professional, evolving to an administrative perspective of a health care manager and finally to a health system perspective as a health services researcher.

As a PhD candidate interested in quality improvement in health care, I was shown the Canadian Teaching Hospital Report, prepared by the Haygroup Consulting group. This report represented a unique opportunity for me to bring together my interests and apply these to my research project. The challenge, however, was to start from the global topic of health care quality improvement and to identify an opportunity to contribute to science. This thesis represents my opportunity to contribute to the methodology used for the study of health care quality.

Description of the thesis

This thesis is organized in four chapters.

Chapter 1 presents an introduction to the topic of performance evaluation in health care. AMI (acute myocardial infarction) hospital mortality rates are presented as an indicator of health care that is often used to compare hospital performance levels. The literature is reviewed to identify studies that have reported variation in AMI hospital mortality rates as a measure of quality. One particular study conducted in Canada is presented, highlighting some problems regarding its methods. This performance study initiated further investigation regarding consistencies and inconsistencies in the methods used when conducting hospital performance evaluations, which in turn initiated the undertaking of this thesis.

Chapter 2 reviews the literature, identifying the methodological variants in hospital performance studies that use AMI mortality as an indicator. Topics covered include inconsistencies in the time frame used to evaluate mortality outcome, patient selection criteria (especially the issue of how transferred patients are dealt with), patient and hospital characteristics that have or have not been dealt with consistently, and health system factors that may influence hospital performance.

The objectives of the study are identified to be:

1. To estimate the extent to which the time frame for AMI outcome evaluation impacts on hospital performance ratings.
2. To estimate the extent to which the inclusion/exclusion of transferred AMI patients impacts on hospital performance ratings.

Chapter 3 presents the methods used in this study. It identifies the source of the administrative data used and defines the study population. The methods used to identify the index admission (the unit of analysis in this study) are provided. As one of the two objectives of this thesis is to estimate the impact of including or excluding transfers from AMI hospital mortality studies, a description is provided regarding how episodes of care were constructed from a flat data file (in other words, the data set contained a single record for each admission, which needed to be linked using common fields such as the patient unique identifier). The research design is presented, stating how each variable was defined and measured for the study. Finally statistical methods are detailed, and information is provided regarding the hierarchical logistic regression models used in the study and how these were applied to compare hospital mortality rates across hospitals. The six analyses, and corresponding models, that are compared are presented. Three analyses are used to compare the impact on hospital mortality rates using three different ways of defining the

mortality outcome. Three analyses are conducted to compare the impact on hospital mortality rates using three different ways to deal with transferred patients.

Chapter 4 contains the results of this study. Descriptive statistics are provided and the degree of variation in hospital mortality rates is presented. Results are compared across the six analyses using four different approaches. First, rank correlations are compared across the six analyses. Second, the movement of hospital mortality rates across quintiles is presented. Third, the movement of hospital mortality rates into and out of the highest and lowest deciles are presented. Finally, hospital rankings are used to identify significant outliers for each of the analyses.

Chapter 5 presents the discussion and includes the principal findings of this study as well as their importance. Findings of this study are compared with others. The strengths and limitations are presented. The implications of this research are discussed and future directions are proposed.

Tables and figures are included at the end of their respective chapters. Appendices are included at the end of the thesis.

Authorship

The candidate assumed the role of principal investigator in all aspects of the study design, the definition and creation of all variables, the statistical analyses, the interpretation of the findings and the preparation of this thesis. It is the intention of the candidate to publish 6 manuscripts from the findings of this study. The candidate will be named first author on each of these articles and will co-author these with members of the thesis committee. The candidate is responsible for the originality of the ideas contained in this thesis, the scientific quality of the research, the accuracy of the data quality and the quality of the report.

Originality

As indicated in the preface, my interest in health care quality has been longstanding. I began my PhD studies in epidemiology with the intent to acquire a solid foundation for research methods used to evaluate the quality of health care services. In discussing these interests with my mentors, I was made aware of the Haygroup report. I was struck by the paucity of the methods presented in this report and began to question the role that methodology played in health services outcomes research. As I reviewed the literature more thoroughly, I became aware of the methodological variants that persisted in the literature. I was particularly interested in two aspects of the methodology used in this area of study.

The first was the issue of how studies typically dealt with transferred patients. Transferred AMI patients are usually excluded from hospital performance studies, or studied separately from non-transferred patients. However, in an era of health care reforms that call for timely care, integrated health services, and efficient health care systems equipped with super specialised facilities, it is not surprising that more AMI patients are

being transferred to specialised centres. I felt this group of patients was sufficiently important to warrant examining the impact of including or excluding them from hospital performance studies. To my knowledge, this is the first study that examines the impact of methods used to handle transfers on hospital mortality rate rankings. To study this question, I independently created all the algorithms and SAS programs used to define the episodes of care and transfers. It is hoped that other researchers studying AMI and other conditions will use this methodology.

The second aspect addressed in this thesis is that of the impact of using 3 different timeframes for defining the mortality outcome. There is considerable debate in the literature regarding which definition to use, but there is little evidence regarding the impact of using in-hospital deaths and death at 30 days post admission, the two most common outcomes used in the literature. I decided to add to these a third timeframe, 7 days post-admission, to reflect current hospital care and practices for the AMI population, involving lengths of stay of 7-10 days. Since the start of my thesis, I came across two studies that have recently investigated this issue. Neither has studied the impact of the methods used to define outcomes on hospital rankings based on AMI mortality and both compared in-hospital deaths with deaths at 30 days post admission.

This research also contributes to the methodology of health care research by using hierarchical models that have not yet been widely applied in epidemiological research. Hierarchical models partition variation into components that can be attributed to patient differences and hospital quality differences. This is particularly interesting for hospital performance studies.

Acknowledgements

I would like to thank my thesis supervisor, Dr. Nancy Mayo, for her guidance and encouragement throughout this thesis. Dr. Mayo has offered a rich learning environment with support at all levels, from resources in the research environment to opportunities to learn with and from other students and researchers. Her mentorship is deeply appreciated.

I would also like to thank my thesis committee members Dr Jay Brophy, Dr Bruno Gagnon and Dr Louise Pilote for their thoughtful insight and prompt feedback. A special thank you is extended to Dr. James Hanley, for his advice and his constructive feedback in regards to the analyses and the presentation of results.

Merci au Dr Pierre Tousignant, qui m'a encouragée dès le tout début de mon doctorat. Thank you to my colleagues and fellow students. A heartfelt thanks goes out to Susan Scott, for sharing her wealth of knowledge in programming SAS and HLM. Merci à Lyne Nadeau pour son appui, sa patience et sa gentillesse. Thank you to my fellow classmates Sarah Ahmed, Lois Finch, Johanne Higgins, and Nancy Salbach who have been supportive and encouraging through thick and thin. Merci à Laetitia Huiart pour son encouragement, son amitié et sa bonne humeur qui ne semble jamais s'épuiser. Thank you to Carmen Kirkness-Asche for her friendship, support and wonderful story sharing, throughout this undertaking! A special thank you to Stéphane Benhamou, for his technical prowess with computers. Few are those who I would have trusted with my computer during this project! Merci à mes amies fidèles, Diane Gilbert et Marie-Thérèse Fournier. Quel privilège pour moi de les avoir comme amies!

Je ne peux pas trouver de mots adéquats pour remercier mes parents, Chantal et Toni, aussi dignement que je le souhaiterai. Leur générosité, leur appui et leur dévouement à l'égard de leurs enfants et petits enfants sont non seulement remarquables mais inépuisables. Je leur suis tout particulièrement reconnaissante pour leur encouragement dès le départ de mon projet, et sans lequel je n'aurais jamais pu réaliser ce doctorat.

Last, but by no means least, thanks Hugh, for being there. Thank you for your kindness and thoughtfulness. Thank you for doing those little things that you do, just to make my life a little better everyday! Thank you for your selflessness, understanding, compassion, and sensitivity.

Acknowledgement of Financial Support

The candidate received personal funding from the NHRDP-CIHR (National Health Research and Development Program – Canadian Institutes of Heath Research) for 3 years and received a one-year award from the CIHR-IHSPR (Institute of Health Services and Policy Research).

Chapter 1 INTRODUCTION

Hospital performance evaluations

Throughout this era of cost constraints and budgetary cutbacks in most developed countries, consumers have continued to value a health care system that delivers quality care and the best possible outcomes (1). Borrowing from industry techniques, health services researchers commonly use comparative studies to demonstrate accountability to the public with respect to the quality of health care services. Referred to as benchmarking, these analyses are the first step to identifying optimal practices from outstanding organizations in order to improve the performance of others (2). A well-known contemporary application of this performance evaluation technique is the comparison of schools and universities using established ranking systems (3). Applied to the healthcare system, benchmark studies compare an organization's performance with that of its peers, to national norms, or to standards set by health care industry leaders (4).

Many countries have developed a core set of indicators within health system performance assessment frameworks that are used to measure and compare the quality of health services across facilities, geographic regions, or health jurisdictions (5-9). A performance indicator quantifies the quality of health care services and is often reported in the form of a rate, a ratio or a proportion (10). Indicators are typically defined within the well-established structure-process-outcome quality of care paradigm (11) and have been adopted by many agencies concerned with the quality of health services (5;12-15).

Structure-indicators of the quality of health care describe characteristics of health care system resources. Examples include the number of health

practitioners per capita, the type of training or licensing they have, the equipment available, the geographic location of services or the volume of specific procedures performed by surgeons or in hospitals (11).

Process-indicators focus on aspects of care that lead to the diagnosis, treatment or prevention of disease. Examples include aspects of health care delivery such as the timeliness, accuracy and appropriateness of care. The basis for using process-indicators is that the "underuse", "overuse" or "misuse" of health interventions can result in harm or death to the very patients who are intended to benefit from these interventions (16;17).

The "underuse" of needed, effective and appropriate care may represent poor quality care. Screening and preventive health care services that are not provided to patient groups who could benefit from these are one example of the underuse of health care services. Likewise, the underuse of appropriate treatments or practice guidelines that are known to be effective in the management of certain diseases are an example of poor quality care. The underuse of appropriate health care interventions may be evaluated for individual patients, with a chart review, or at the level of an entire population by monitoring the rates of specific services or procedures that are known to be related to disease prevention or to better coordination of care and follow up (17).

The "overuse" of medical care can also represent poor quality care if patients undergo unnecessary procedures that may place their health at risk. Examples of medical procedures that pose varying degrees of risk to patients include excessive use of X-rays, unnecessary surgeries, or over-prescribing of medications. While each of these medical acts poses a direct risk to patients, they also represent a waste of resources when they

are used needlessly. Thus, overuse of medical care can lead to poor quality care directly and indirectly (17).

The "misuse" of medical care is the third type of process-indicator that is used to assess the quality of health care and that can represent poor quality care. Examples are medical errors that include: avoidable drug interactions, surgical errors, or lack of follow up care after abnormal test results (17).

Finally, outcome-indicators include patient survival, mortality, morbidity and complication rates, and more recently, health and functional status indices and profiles. In order for an outcome to be a valid reflection of the quality of health services, it must be linked with processes of care that can be modified and that can therefore influence that particular outcome of interest (17). Therefore, health outcomes that are influenced primarily by factors that are unrelated to processes of care are less suitable for use as indicators of performance.

Some authors advocate the use of process indicators to profile hospital performance, arguing that hospitals have more control over the processes of care than they do over the outcomes of care (18). However, outcomes are often used as performance indicators for two reasons. First, outcomes matter to the public, to clinicians, to administrators and to policy makers. Second, outcomes of health care may be measured more directly than processes of care, which involve complex clinical decisions (18;19).

A key feature in the selection of health care performance indicators is the causal link between processes and outcomes, including links that form the foundation of evidence-based clinical practice guidelines. Quality of care depends largely on the application of clinical interventions that have been shown to be effective (4;20) and on the structures and processes of health

care systems and organizations that allow predictable and desirable outcomes to be attained (16). While we would expect health care services to be coherent with proven therapies, marked variations persist among health systems and organizations in the degree to which such interventions are used (21-23). Yet achieving desirable health outcomes rests partly on the ability to achieve predictable outcomes that in turn depend on stable and invariable processes of care across hospitals[1].

Variation in health care delivery and health outcomes

Variation in medicine has been defined as "the observation of differences in the way apparently similar patients are treated from one health care setting to another", being "neither good nor bad", but for which an important goal of measurement should be to "distinguish variation that is valuable and desirable from that which is valueless and perhaps undesirable" (24).

Measurement of variation

Variations in health care performance indicators are evaluated using methods that have evolved from those developed for small area variation analysis, or simply small-area analysis (SAA) (25). From a population health perspective, these variations have been used for some time now to

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[1] Clearly, health care provision cannot and should not be completely free of variation, since interventions must be selected as a function of specific patient profiles. Nonetheless, industrial quality management methods continue to be adopted in health care, including the control of unintended variation. In the context of health care, undesirable variation derives from several sources, including the misinterpretation of clinical data, the unreliability in the performance of clinical care, and the differences in practice that are not founded on scientific evidence (238). The premise behind quality management efforts is that these can reduce unintended or undesirable variation without infringing upon professional autonomy, dignity, or purpose of health care professionals.

monitor the equality of resource distribution and effectiveness of health care across areas (26). "Areas" studied may include geographic regions (7), health jurisdictions (such as health districts, counties or regional health authorities) (27), physician groups (28), or hospitals (29). In the past three decades, numerous studies have estimated the degree of variation in health care indicators. There has also been a wide range of objectives for these variation studies.

Ensuring access to appropriate health services for marginalized groups is an important issue worldwide (30;31). Several published studies have reported inequities in the availability or access to health care services across population subgroups, defined according to demographic characteristics such as age, gender, SES or race. The objective of these studies was to identify socio-demographic characteristics that may influence access to health care services, which may turn affect health outcomes. Studies have reported difficulties in access to health services for older individuals, females, non-whites, and individuals from low socioeconomic backgrounds (32-45).

Variations in the appropriateness of health care services have also been monitored by comparing rates of specific diagnostic tests, therapies, follow-up care, and evidence-based surgical interventions (known to be effective) across regions or facilities. Population rates for follow up care, for medical therapies (use of beta-blockers, aspirin, and smoking cessation advice) and for procedures (angiography, and reperfusion) among AMI patients have been compared among regions in order to examine whether differences in these rates are associated with differences in mortality rates or readmission rates (46-51). Variations have also been monitored for medical procedures that are considered to be "primarily discretionary", "primarily non-discretionary", and "intermediate" (52). Procedures that are considered to be "primarily

discretionary" include those for which there is little agreement regarding necessity or indications. Examples of "primarily discretionary procedures" include tonsillectomies, hysterectomies and inguinal hernia repair. "Primarily non-discretionary" procedures are those for which there are few alternative treatment options, and these include pacemakers, skin grafts, lower limb amputation and lung surgery. "Intermediate" procedures are those for which there is an intermediate degree of discretion, such as appendectomies, carotid endarterectomies, and coronary artery bypass grafts (CABGs). When comparing population-based rates across regions or facilities for these types of procedures, greater variation is expected for discretionary procedures than for non-discretionary procedures (53).

An important factor that contributes to greater variation in discretionary procedure rates is the uncertainty regarding clinical indications for these procedures (54). Hence, excessive use of procedures that are deemed discretionary may signal the need to establish more definitive clinical practice guidelines in order to reduce such variation (55;56).

High volumes for procedures are sometimes sought when these lead to more desirable outcomes. For example, higher volumes of procedures performed by some surgeons or in some hospitals are inversely related to the risk of operative or post-operative mortality (28;57;58). This relationship between high volumes of procedures and more desirable outcomes is one reason why there are highly specialised facilities in regionalised health care systems, mandated to treat local patients as well as those who reside outside the hospital's local service area (59).

Measures of variation are also used to monitor efficiencies in health care delivery by comparing indicators such as hospital LOS and health care costs. When comparing these indicators of efficiency, it is important to ensure that lengths of stay and costs are not reduced to the detriment of

patient health and safety. Hence, studies that compare indicators of efficiency across regions also compare health outcomes, such as mortality rates (60-62).

Health outcomes can be compared on their own as well, as a means to evaluate the performance of the health care system. Health outcomes can be compared across time, population subgroups, facilities, geographic regions, and health care system jurisdictions (such as provinces, states, countries). Mortality rates represent one type of outcome measure that is commonly used to compare health care system performance levels (51;58;63-72).

Thus, researchers have applied Small Area Analyses (SAA) to compare the highest and lowest rates of events across "areas" (geographic regions, population groups or health jurisdictions), to determine whether differences in event rates across these areas or groups were large, or to attempt to explain these differences as a function of specific factors (25). In the 1970s and early 1980s, when patient level information was not readily available, SAA methods used to study variations in health care delivery and effectiveness relied on aggregate data (73). Earlier analyses used variation estimators such as the Extremal Quotient (EQ), the Coefficient of Variation (CV), the Systematic Component of Variation (SCV), and the Chi-square statistic (25).

The Extremal Quotient (EQ) is the ratio of the highest observed rate to the lowest rate among the areas studied (74). This measure of variation can be infinitely large if some areas have low event rates or if some areas are small (25).

The Coefficient of Variation (CV) is the ratio of the standard deviation to the mean (75). In the context of small-area analysis, the CV represents

the ratio of the standard deviation of event rates among small-areas to the mean rate of events among small-areas (25).

The Systematic Component of Variation (SCV) is a descriptive statistic developed to estimate the variability between area-specific rates while taking into account the variability in the event rate within each small-area (76). It therefore estimates the variance among small areas that cannot be accounted for by the variation within each area (25).

The Chi-square statistic can also be used to test for differences in the rate of events across areas. This measure is appropriate if all individuals in each area have the same probability of having the event, and if the expected number of events is at least five in each area (25).

The above methods were often used to estimate small area variation (27), but could not adequately account for multivariate risk adjustment (although SAA were often performed using age-sex-adjusted rates) without person-level data. Earlier studies relied on aggregate data, before person-specific data became more readily available (77). As administrative databases and data repositories have evolved to contain more detailed information on individuals, so too have the methods used to estimate the variation between "small areas" evolved over time. For example, in the mid-1980s, the Health Care Financing Administration commissioned quality reviews to study variations in outcomes of care between regions and between hospitals (78). Hospital and regional comparisons were conducted using multivariate regression analyses that allowed for adjustment of severity of illness and other factors in addition to age and sex. Patient-specific records allowed researchers to use multivariate regression models to study variations in practice patterns (79) and to compare health care outcomes (72) across regions or hospitals, while taking into account various factors that may explain these differences.

Statistical methods that are commonly used today to estimate variation in health care delivery and effectiveness include: multivariate regression models (37;54;58;60;62), proportional hazards models (47), and hierarchical regression models (33;51). These methods are presented in greater detail in the Methods section entitled "Statistical methods", on pages 72 to 86.

Variation in health outcomes as a measure of quality of health care delivery

In the context of quality improvement, the presence of unintended outcome variation is considered an opportunity to improve processes of care and to achieve more desirable outcomes such as eliminating avoidable adverse events, reducing the burden of illness, improving health and improving quality of life (22;24). After accounting for risk differences among patients, differences in health outcomes can signal variations in the delivery of appropriate health care and can lead to identifying opportunities for improvement (80). The notion that undesirable outcomes stem from poor processes forms the basis of quality management models that were originally developed for industry (81-84). These models have been adapted to the health care sector with the advent of well-founded clinical practice guidelines (85;86) and have led to widespread efforts to develop appropriate indicators.

An example of an outcome indicator that has been used for some time to measure quality is hospital-specific patient mortality rates (72;87). While some studies have compared all-cause mortality rates across hospitals (88-91), conducting hospital mortality comparisons for specific diagnoses may be more meaningful. A hospital's performance level may depend on

its area of expertise and may therefore be different according to the type of condition treated (92). Furthermore, mortality rates may not be the most appropriate outcome to measure for terminal conditions such as cancer, for which survival times may be a more meaningful indicator of quality of care (93).

Today, when used as performance indicators, hospital mortality rates are compared for specific patient groups or medical interventions. One such group is patients admitted for an acute myocardial infarct (AMI). In fact, hospital mortality rates have been included in a Canadian list of indicators established for AMI patients (94).

The epidemiology of acute myocardial infarction

Hospitalization and mortality rates

Given the large number of deaths and hospitalizations due to AMI, it is not surprising that this indicator is used at a national level. In Canada, it is estimated that there are more than 70,000 heart attacks each year (95) and in 2001, nearly 19,000 Canadians died from an AMI. The number of AMI deaths has decreased from 29,483 deaths in 1980 to 20,926 deaths in 1999 (Figure 1-1). There has also been a decline in the AMI age-standardized mortality rates (from 149 deaths per 100,000 persons to 63 deaths per 100,000 persons) (Figure 1-2), although this decrease has been substantially greater among men than women (Figure 1-3). Most deaths due to AMI occur before patients reach the hospital (96-98), although public education and improvements in pre-hospital care and transportation to hospitals have allowed more patients to reach a hospital alive. AMI hospital admissions have increased from nearly 49,000 admissions in 1980 to more than 62,000 AMI admissions in 1990 (Figure 1-4). In fact, the steady decrease in mortality from ischemic heart disease (which includes AMI) in North America has been attributed to efforts on all

fronts of the health care system. It is estimated that 25% of the decline is attributable to efforts in primary prevention, 29% is attributable to secondary prevention, and 43% is attributable to improvements in the medical management of AMI (99).

Risk factors for AMI

Risk factors for AMI include age and sex and family history of coronary artery disease (99). Modifiable risk factors include smoking, physical inactivity, being overweight, high blood pressure and diabetes (99;100). Abnormally elevated cholesterol, low-density lipoproteins (LDL) and triglycerides, and low levels of high-density lipoproteins (HDL) are also important risk factors for developing coronary artery disease, which can be managed with pharmacological treatments.

Practice guidelines for the prevention and treatment of AMI

The reduction in the occurrence of AMI and in the mortality rate associated with this condition is largely attributable to evidence-based guidelines that have been made available to clinicians. The American College of Cardiology and the American Heart Association have published guidelines for the prevention of heart attacks (100) and for the management of patients with AMI (101). Concomitantly, there has been a reduction in the average length of stay for AMI patients admitted to acute care hospitals in Canada (Figure 1-5), where the average length of stay for an AMI admission has decreased from 9 days to 8 days between 1994 and 1999. Furthermore, there are differences in the average length of stay between provinces. Quebec has had the highest length of stay for AMI patients, although there has been a substantial decline in the length of stay in this province, from 11.5 days to 9.5 days between 1994 and 1999.

For AMI patients admitted to hospital, medical interventions have been shown to reduce mortality, provided these are consistently administered in a timely manner (102;103). In the context of quality management of health care, it is therefore important to monitor the extent to which clinical practice reflects these evidence-based guidelines. One approach would be to evaluate the processes of care provided to each patient, which would require considerable time and resources, given the complex clinical decisions involved (18;19). Another alternative would therefore be to monitor the outcomes of the care provided to AMI patients, on the premise that less variation in practice is expected to lead to more predictable outcomes.

Variation in AMI mortality rates

Many studies have emerged in the literature, that measure variation in hospital mortality rates as a way to assess the quality of care for AMI patients (71;72;88;104-108). Interest in this indicator has not been exclusive to the scientific community. In fact, AMI hospital mortality rates have been compared and reported in national studies (91;109-112) and provincial or state-wide studies (113-119). In addition, commissioned studies on the performance of hospitals and other health services have reported their findings in the lay media (91;120-123). (Table 1-1).

Despite the interest generated in the literature regarding hospital mortality rates as a measure of quality of patient care, there are ongoing discussions and inconsistencies in the methods used to address variations in hospital performance. Therefore, caution must be exercised with respect to the conclusions drawn from comparative evaluations as the methods vary widely across studies (124).

Rationale

This thesis was prompted by a commissioned study that compared indicators across teaching hospitals in Canada (91). One of the indicators reported was in-hospital mortality rate. For two consecutive years, a Montreal teaching hospital was identified as having the highest adjusted mortality rate among all those compared, leading to considerable concern and a request to investigate the reasons why the level of performance was less than desirable. However, the methods used in this commissioned study were problematic and needed to be addressed before pursuing the next question of "why are hospital mortality rates higher than expected in this particular hospital?"

First, the commissioned study referred to above included all patient groups, including cancer, geriatric, and trauma patients. Although admissions identified as palliative care were excluded from the study, not all patients in the advanced stages of diseases are identified as occupying a palliative care bed. Furthermore, mortality rates are not the most appropriate outcomes to use for terminal conditions, since patients with these diagnoses will inevitably die, and mortality rates will be influenced by the number of patients admitted with these diagnoses as well as by the extent to which the denominator (total number of admissions) is inflated.

One way the denominator may be inflated is by counting each admission separately. For example, in the commissioned study, the unit of analysis used to compare hospital mortality rates was each admission. The numerator contained the total number of cases (admissions) who died, and the denominator contained the total number of "cases", consisting of individual admissions. The expected mortality rate was calculated for each hospital, based on its patient mix that was defined according to the combination of case mix groupings (diagnostic groups), complexity level (range 1-4) and age group (3 groups). The ratio of the number of

observed deaths compared to the number of expected deaths was calculated for each hospital. Hospitals with mortality ratios greater than 1.0 were identified as having a higher than expected mortality rate. However, differences in discharge practices may have over- or under-estimated risk-adjusted mortality rates due to a selection bias. Specifically, hospitals that discharge patients early and subsequently readmit them for follow up care would have a lower mortality rate compared to hospitals that keep their patients for longer stays, since these hospitals would have double counted some admissions, thereby appearing to have treated a greater number of patients.

When using administrative data bases that are structured such that each record constitutes a single admission, episodes of care need to be constructed in such a way as to ensure that differences in discharge practices will not lead to an over or under counting of the number of eligible admissions that belong to a single episode of care (124). Otherwise, the selection of each individual admission in a study will create a systematic bias leading to an underestimation of the mortality rate among hospitals that readmit patients.

It has been recommended that specific patient groups should be studied separately when comparing hospital mortality rates (92) as issues pertaining to risk adjustment, construction of episodes of care, and outcome definition may differ from one patient group to another. AMI patients are one of the populations among which hospital mortality rates are compared in performance evaluation studies, partly because this is a large patient group that experiences a relatively high mortality rate (71;109;110;112;113;116;118).

Second, the commissioned study excluded all transfers from its evaluation, which may not appropriately reflect tertiary hospital

performance levels in their entirety. These hospitals often receive transferred patients and assume the role of "rescue hospitals"[2]. In Quebec, there were more than 10,000 index AMI admissions[3] that resulted in a transfer to a second acute care hospital between 1992 and 1999. Tertiary care hospitals received more than 9,200 of these transferred patients, which accounted for more than 32% of their index AMI patient population (Table 1-2). Transfers to other types of hospitals accounted for less than 2% of all AMI index admissions.

Timely and appropriate care for AMI patients, including transfers to a tertiary care facility, is an important determinant of outcome (102). On the other hand, patients who are too unstable to be transferred are also more likely to die. Therefore, there can be a selection bias in studies that exclude transfers, resulting in an overestimate of the adjusted mortality rate for hospitals that provide good quality care by appropriately transferring patients who benefit from being treated at an alternative facility.

Third, the outcome used to compare performance was in-hospital mortality. This outcome can lead to a biased mortality rate due to a differential misclassification of the outcome, where patients are discharged earlier from some hospitals than from others, and where premature discharge from hospital following an AMI can result in death out of hospital or in a subsequent admission in some other hospital (125). Bias occurs because hospitals providing poor care (by discharging patients

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[2] The term "rescue hospital" is used in this thesis to refer to hospitals that receive patients transferred from another hospital where the index AMI admission occurred.

[3] The term "index AMI admission" is defined in Chapter 2 as being the initial AMI admission in an episode of hospital care, where an episode of care consists of a series of consecutive admissions for a unique patient (118). In this study, an index AMI admission cannot have been preceded by another AMI admission in the year prior to its occurrence. This topic is covered in further detail under the "Patient Selection Criteria" section of Chapter 2.

prematurely) are rewarded for discharging a patient alive, even though the patient subsequently dies because of this poor care.

Fourth, the case-mix adjustment method used in the commissioned study uses data reported to the National Discharge Abstract Database by all provinces except Quebec (7). Quebec data needed to be transformed for the purpose of the Canada-wide study, which may have compromised comparability in the findings (91). Although not previously assessed, a systematic difference in the risk-adjustment index for Quebec data compared to data from other provinces would result in bias due to systematic measurement error.

Further exploration of these problems brought to light some important inconsistencies in the literature regarding the methods used by researchers when conducting comparative hospital performance studies. This thesis was initiated in order to investigate some of these inconsistencies.

Chapter 2 describes various methods used in the literature to conduct AMI hospital mortality comparative studies. In Chapter 2, consistencies and inconsistencies are identified in:

1. Methods used to define the mortality outcome that may lead to differential misclassification of the outcome
2. Patient selection criteria that may lead to selection bias by excluding transferred patients, who are treated appropriately
3. Patient characteristics that are unaccounted for and that may lead to residual confounding biases
4. Hospital characteristics that are unaccounted for and that may lead to residual confounding biases

Tables and Figures pertaining to Chapter 1

Table 1-1: Comparative hospital performance studies conducted

Studies published in scientific literature	Place	Year of Study	Data Source	AMI Population studied	Unit of Analysis
The ratio of observed-to-expected mortality as a quality of care indicator in non-surgical VA patients. (104)	US	1994	Blinded chart review	US Veterans Affairs hospitals Non-surgical patients (AMI included) (1981-82) and (1985-86)	Patients within hospital
Interhospital variations in admission severity-adjusted hospital mortality and morbidity. (88)	Pennsylvania	1991	MedisGroups Comparative Database	Patients admitted to 20 Pennsylvania hospitals 1996-1998	Admissions within hospital
Risk-adjusted in-hospital death rates for peer hospitals in rural and urban regions. (105)	Tennessee	1999	Commercial Insurance Claims	Patients admitted to all Tennessee hospitals 1992	Patients within hospital
Population-wide mortality trends among patients hospitalized for acute myocardial infarction: the Ontario experience, 1981 to 1991. (71)	Ontario	1994	Administrative data	Ontario hospital discharges 1981-1991	Admissions within hospital
Hospital Outcomes in Major Teaching, Minor Teaching and Nonteaching Hospitals in new York State. (106)	New York State	2002	Hospital administrative database	New York State discharge records. 1993-1995	Patients within hospital
Severity-adjusted mortality and length of stay in teaching and nonteaching hospitals. Results of a regional study. (107)	Northeast Ohio	1997	Data abstracted from patient records	Patients discharged from 30 hospitals (1991 - 1993	Patients within hospitals

Table 1-1: Comparative hospital performance studies conducted (Continued)

National Studies	Place	Year of Study	Data Source	AMI Population studied	Unit of Analysis
Cooperative cardiovascular study (109;110)	Oklahoma	1997	Health Care Financing Administration claims database	Medicare data 1993-1994	Patients within hospitals
Health Care Financing Administration (from this, Cooperative Cardiovascular Project subsequently emerged) (112)	US	1995	Health Care Financing Administration claims database	Medicare data 1988-1990	Patients within hospitals
Haygroup Hospital Report (91;126;127)	Canada	1998	Hospital discharge databases	All patients admitted to teaching hospitals in Canada	Admissions within hospitals

Table 1-1: Comparative hospital performance studies conducted (Continued)

Statewide / Provincial Studies	Place	Year of Study	Data Source	AMI Population studied	Unit of Analysis
California Hospital Outcomes Project - Report on Heart Attack (113-115)	California	2002	California Hospital Discharge data set and the Vital Statistics data base	Patients admitted to hospitals in California (1996-1998)	Patients within hospitals
Cardiovascular Health and Services in Ontario (116)	Ontario	1999	Ontario Myocardial Infarction Database (OMID) - links Ontario's major health care administrative databases	Patients hospitalized to Ontario hospital (1994-1997)	Patients within hospitals and within District Health Councils
Pennsylvania Focus on Heart Attack (117-119)	Pennsylvania	1996	Uniform Billing Forms and Key Clinical Findings abstracted from hospital records using MediQual Systems	Heart Attack cases treated in Pennsylvania (1993)	Cases within hospitals

Table 1-1: Comparative hospital performance studies conducted (Continued)

Public or Commissioned Studies	Place	Year of Study	Data Source	Indicators reported	Unit of Analysis	Reporting frequency
MacLean's Magazine. The best health care (Health Report - The Annual Ranking) (123)	Canada	2000	National data (CIHI)	Varia, includes: Life expectancy, low birth weight, preventable admissions	Health Regions	Yearly
US News and World Report. America's best hospitals: Heart and Heart Surgery. (120;128)	US	2002	Secondary data sources, such as the American Hospital Association (AHA) Annual Survey of Hospitals.	Index includes structure process and outcome measures; outcome was risk adjusted mortality rate (using 3M APR-DRG risk adjustment methodology)	Tertiary care hospitals	Yearly
Haygroup Study (91)	Canada	1998	Hospital discharge databases	All cause in hospital mortality	Teaching Hospitals	Yearly
HCIA-Sachs Study: Solucient 100 Top Hospitals: Benchmarks for Success. (122;129)	US	1999 2000 2001	Medicare cost and discharge data	Risk adjusted AMI mortality, by hospital type	Hospitals	Yearly
AQHC New York State Inpatient Quality Indicators. (130)	New York State	2001	Administrative data	Varia, includes: AMI hospital mortality	Hospitals	One time only

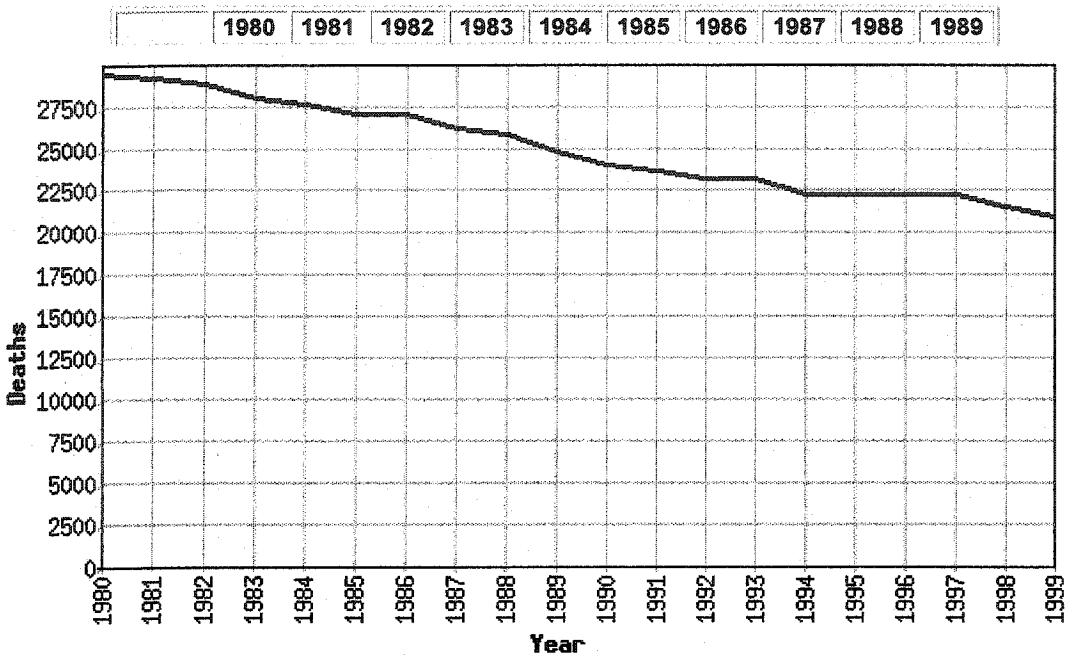
Table 1-2: Ratio of AMI direct admissions to transfers, by hospital type All Quebec acute care hospitals, 1992-1999

		Type of acute care hospital*					
		Non-tertiary care hospital		Tertiary cardiac care hospital		Total	
Source of admission	Direct admission**	61,797	*98.2%*	19,441	*67.7%*	81,238	*88.7%*
	Transferred from another facility	1,102	*1.8%*	9,293	*32.3%*	10,395	*11.3%*
		62,899	*100.0%*	28,734	*100.0%*	91,633	*100.0%*

* Hospital categories are defined by availability of revascularization facilities

** Patients admitted from home, or other residence. Does not include patients who were transferred to another facility at the end of the index admission

Figure 1-1: Mortality over time, acute myocardial infarction, number of deaths, both sexes combined, all ages, Canada, 1980-1999

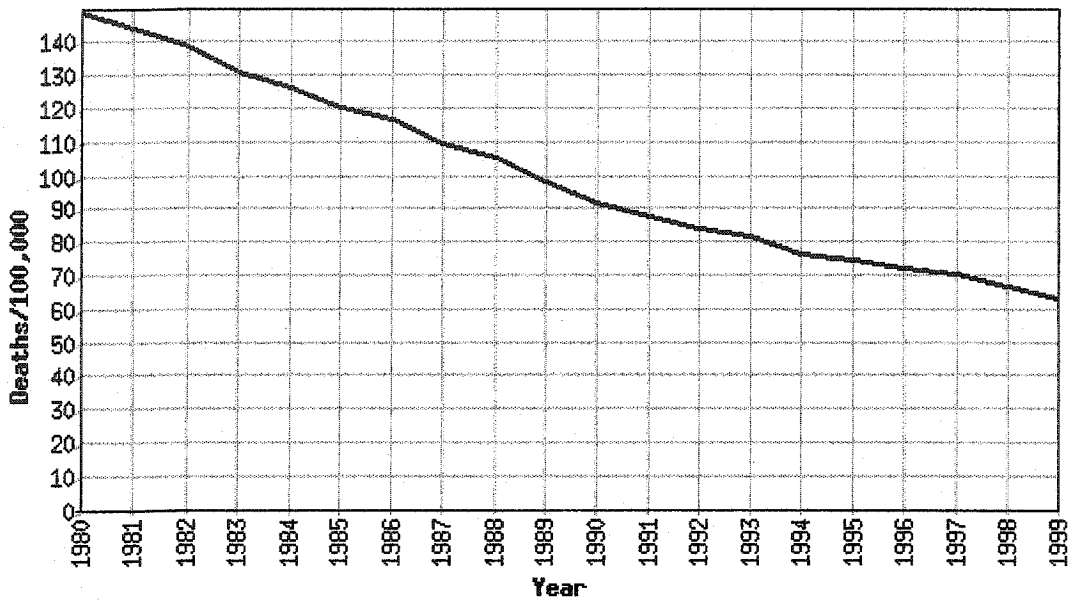


	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Deaths	29483	29215	28845	28027	27652	27045	27071	26288	25861	24859

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Deaths	24022	23623	23208	23208	22252	22214	22210	22238	21516	20926

Source: Health Canada, Cardiovascular Disease Surveillance On-Line, using
Mortality Data: Laboratory Centre for Disease Control, Statistics Canada, 2002
Hospital Separations Data: Canadian Institute for Health Information (CIHI), data transformations by LCDC, 2002

Figure 1-2: Mortality over time, acute myocardial infarction, age-standardized rate per 100,000 to both sexes, Canada 1991. Both sexes combined, all ages, Canada, 1980-1999

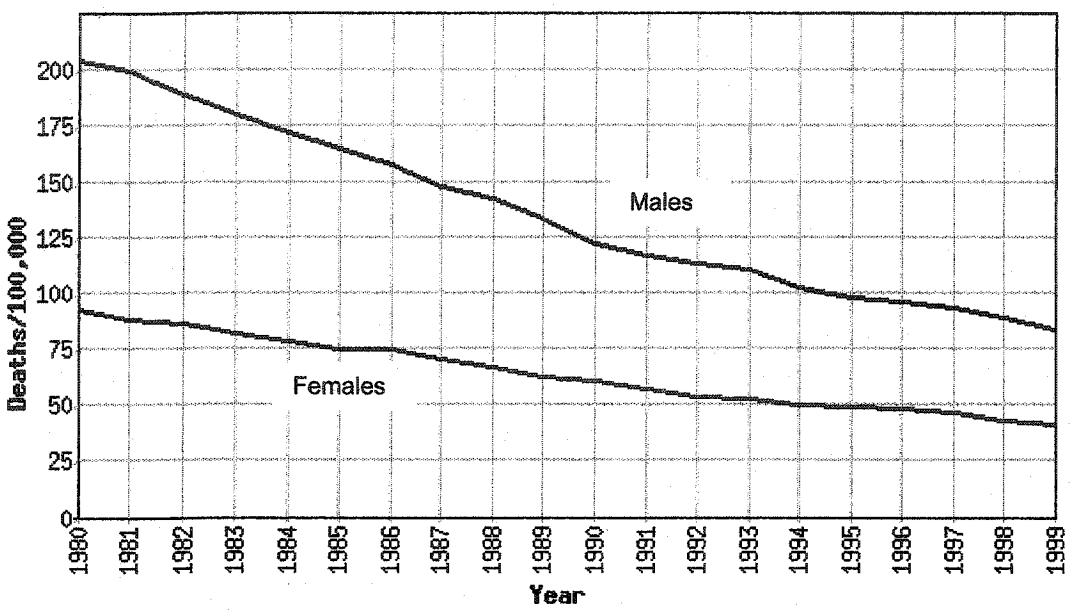


	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Deaths/100,000	149.17	144.63	138.72	131.39	126.25	120.44	117.06	109.98	105.71	98.54

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Deaths/100,000	91.90	87.61	84.10	82.07	76.65	74.48	72.60	70.68	66.80	63.13

Source: Health Canada, Cardiovascular Disease Surveillance On-Line, using
Mortality Data: Laboratory Centre for Disease Control, Statistics Canada, 2002
Hospital Separations Data: Canadian Institute for Health Information (CIHI), data transformations by LCDC, 2002

Figure 1-3: Mortality over time, acute myocardial infarction, age-standardized rate per 100,000 to both sexes, Canada 1991. By sex, Canada, 1980-1999

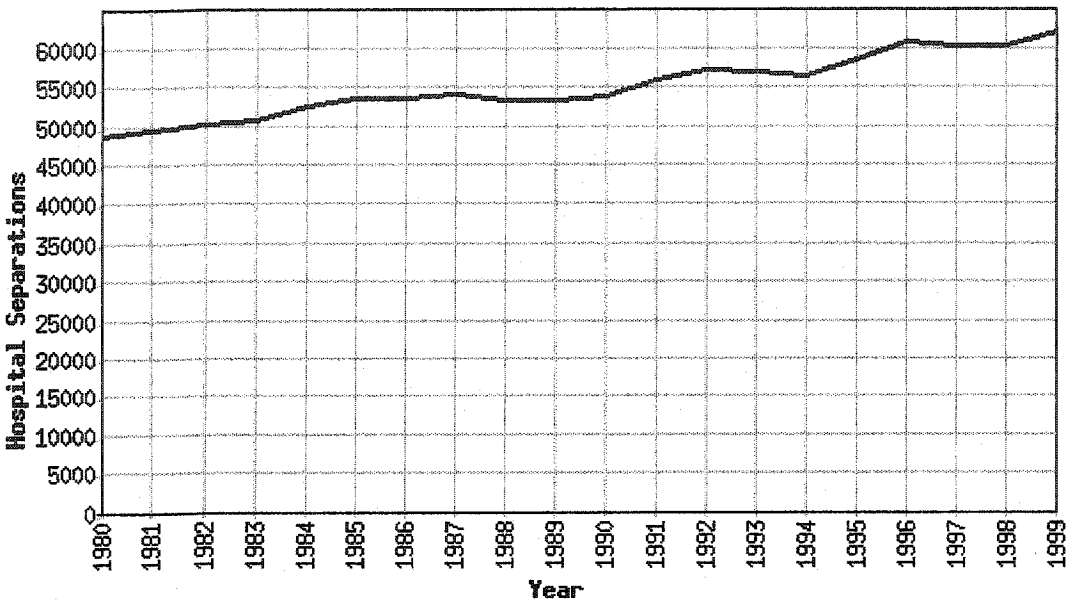


		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Males		204.94	200.42	190.00	180.61	173.12	165.44	158.85	149.03	143.69	134.20
Females		93.40	88.85	87.44	82.17	79.38	75.44	75.26	70.93	67.73	62.87

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Males		123.02	117.35	113.90	111.15	103.07	99.01	96.84	94.21	90.09	84.75
Females		60.79	57.87	54.29	52.99	50.24	49.96	48.36	47.16	43.51	41.50

Source: Health Canada, Cardiovascular Disease Surveillance On-Line, using
Mortality Data: Laboratory Centre for Disease Control, Statistics Canada, 2002
Hospital Separations Data: Canadian Institute for Health Information (CIHI), data transformations by LCDC, 2002

Figure 1-4: Hospital separations* over time, acute myocardial infarction, number of hospital separations. Both sexes combined, all ages, Canada, 1980-1999

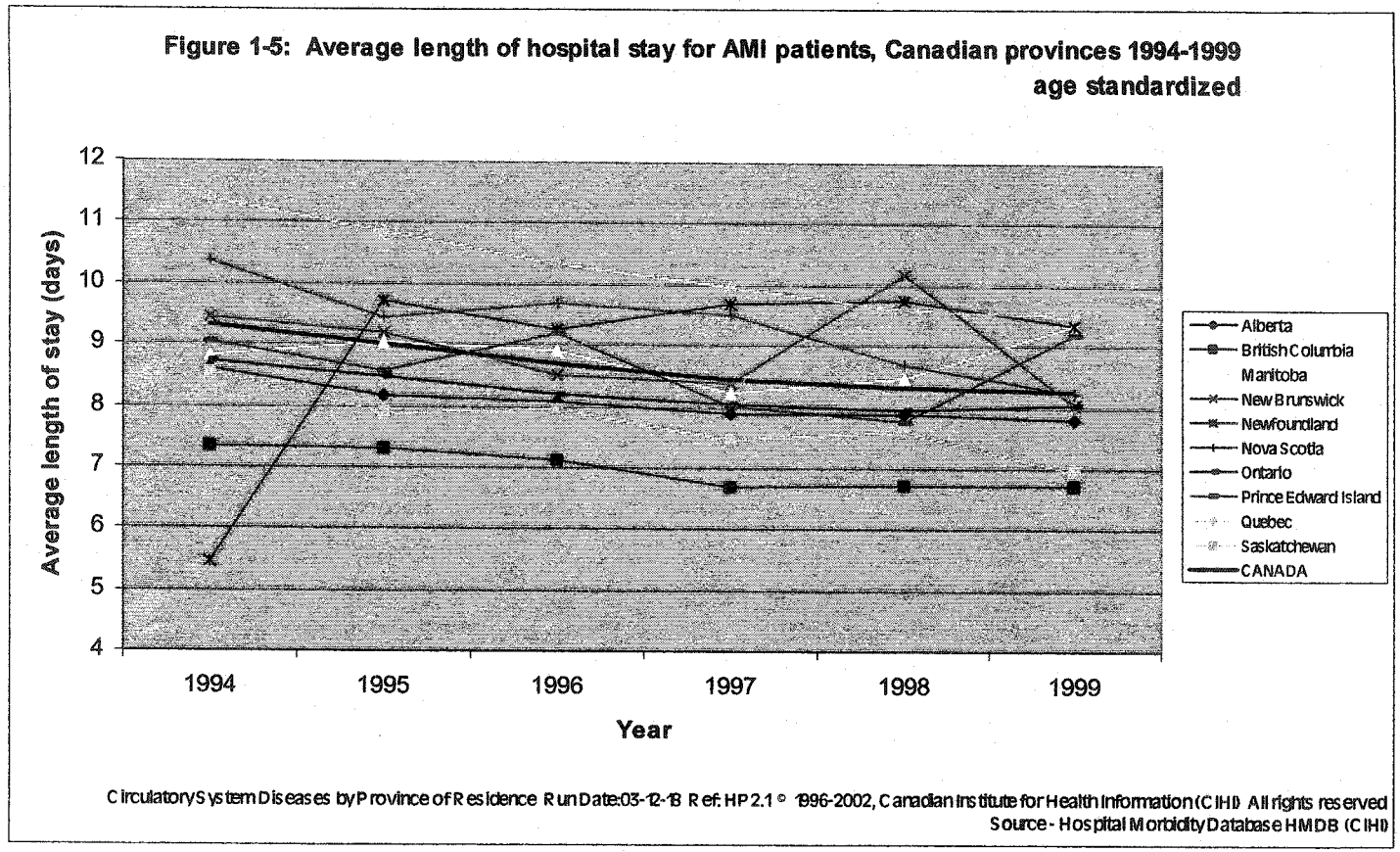


	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Hospital Separations	48,905	49,757	50,526	50,865	52,785	53,715	53,700	54,412	53,430	53,461
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hospital Separations	53,975	56,213	57,453	57,232	56,582	58,689	61,080	60,554	60,398	62,368

* It should be noted that these data are based on hospital separations and reflect the number of episodes (event-based) rather than the number of patients (person-based). Therefore, five hospital separations could mean that the same person was admitted five times or that five different individuals were admitted and subsequently discharged/deceased. As well, this database does not capture those individuals who are not hospitalized but have the disease.

Source: Health Canada, Cardiovascular Disease Surveillance On-Line, using
Mortality Data: Laboratory Centre for Disease Control, Statistics Canada, 2002
Hospital Separations Data: Canadian Institute for Health Information (CIHI), data transformations by LCDC, 2002

Figure 1-5: Average length of hospital stay for AMI patients, Canadian provinces 1994-1999, age standardized



Chapter 2 BACKGROUND

Methodological variants in hospital performance comparative studies using AMI mortality as an indicator.

Methods used to define the mortality outcome

Given the drive to maximize health system efficiencies and given the availability of advanced medical technologies, there has been a general trend for AMI patients to have shorter stays in acute care hospitals (see Figure 1-5). Despite this overall downward trend, differences in discharge practices have emerged across hospitals, leading to variations in lengths of stay (LOS) that are not exclusively attributable to the patient's level of illness (60). This situation poses a problem in hospital performance studies that use in-hospital deaths as a mortality outcome as patients who are discharged prematurely are less likely to die in hospital, but may be as or more likely to die after discharge than patients who remain in hospital for longer stays (125). Researchers have therefore argued that a more appropriate mortality outcome to use would be death within 30 days of the AMI index admission date, regardless of whether death occurs in hospital or elsewhere (115). Some studies have extended this follow-up period to 180 days or 1 year after the index date of admission (112) whereas others have pointed out that such a prolonged timeframe may reflect the quality of community health care rather than that of acute care following an AMI (114). Given these arguments, hospital profile studies continue to use various time frames to evaluate death as the outcome of interest following an AMI admission (Table 2-1).

Researchers have recently begun to investigate the effects on hospital rankings of using different definitions for mortality outcome among AMI

patients. One study has found differences in hospital performance according to different combinations of outcomes evaluation time frame and cause of death measured among surgical patients (131). Another study has found similar SMRs (Standardized Mortality Rates) using in-hospital or 30-day mortality among patients with congestive heart failure (132). No study to date has estimated the impact of using different time frames for evaluating outcomes on hospital rankings in the context of performance studies using AMI patients. Furthermore, it is likely that the appropriate time at which mortality outcomes should be measured may vary for different conditions (133).

Patient selection criteria

Defining the index admission

Table 2-2 displays various methods described in the literature to define AMI index admissions for comparative hospital performance studies. Generally, the index AMI admission is the initial admission in an episode of care, where an episode of care consists of a series of consecutive admissions for a unique patient (118). Some studies have included more than one index admission for a single patient with several AMI events, treating each index admission as a separate unit of analysis (114). However, the inclusion of repeat observations for each patient violates the independent observations assumption of statistical models used to analyze these data, leading investigators to include only the first AMI admission in the study period for each patient (124).

Patients can return to hospital for diagnostic evaluations or for coronary revascularization procedures at a later date following the index AMI admission. Because administrative datasets typically log each admission

separately, it is important to distinguish the index AMI admission from repeat admissions that constitute treatment for the same event. Researchers have therefore excluded questionable index admissions, identified as those for which a previous AMI admission had occurred within a specified period of time, ranging from 8 weeks to 1 year prior to the index admission (114;134).

Administrative databases generally record the "most responsible diagnosis[4]" or the "principal diagnosis[5]" as the main diagnosis for each admission. These do not necessarily reflect the patient's diagnosis at the time of admission. In other words, an AMI diagnosis may be a complication of care rather than the primary reason for admission, where the former may represent a marker for poor quality care and the latter identifies the intended study population (105;135). Some databases have the necessary codes to distinguish between these two types of AMI diagnoses, in which case researchers have excluded patients with AMI as a complication of care and have identified index admissions as those for which AMI was a primary diagnosis (114;116). Where administrative codes do not differentiate between the two types of AMI admissions, researchers have limited the study population to include only emergency admissions for AMI (136).

Patients may sometimes be admitted with symptoms similar to those of AMI, which is eventually ruled out after a period of observation in hospital. To address this issue, some authors have excluded patients discharged alive with a total length of stay of less than four days, on the assumption that AMI had been ruled out for these patients, even though the diagnosis

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[4] The most responsible diagnosis is defined as being the diagnosis that is responsible for the largest proportion of the hospital stay and for the largest proportion of costs associated with that hospital stay (116;134)

[5] The principal diagnosis is defined as the diagnosis that is considered to be the primary reason for the admission. It is assigned at the time of discharge and may therefore be different from the diagnosis first given to the patient at the time of admission. (209).

of AMI remained on their record (116). Other authors have used a shorter cut off period to exclude patients on this basis (105). Given varying discharge practices among hospitals, it is important to select a cut off LOS that takes into account current clinical practices, which tend towards reduced hospital length of stay for AMI admissions.

Inter-hospital Transfers

While most hospitals are equipped to provide medical management of AMIs, invasive cardiac procedures such as Percutaneous Transluminal Coronary Angioplasty (PTCA) and Coronary Artery Bypass Graft (CABG) are offered at specially equipped facilities (137;138) (see Appendix 1 for descriptions and illustrations of revascularization procedures: PTCA and CABG). Patients needing more advanced services may therefore need to be transferred from a less equipped facility to a specialized cardiovascular care centre.

Annual volumes of revascularization procedures have been on the rise in Quebec and elsewhere (139). For example, the yearly volume of PTCAs performed in Quebec has increased from 6,600 in 1996 to more than 10,000 in 2000 (Figure 2-1). Annual CABGs performed also increased from 5,200 to 6,000 during the same period of time (Figure 2-2). These procedures are performed in hospitals that are equipped with highly specialised facilities in Quebec, and that are mandated to provide services to local patients in addition to patients who reside in other regions (59). Corridors of service[6] are intended to reflect current cardiac care practice

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[6] Corridors of service consist of referral paths intended to facilitate and ensure access to appropriate care. They consist in part of clear definitions of hospital mandates at the local, regional and supra-regional levels. Corridors of service are intended to reduce duplication and redundancies in the health system (ie: promoting health care system efficiencies) and to optimize outcomes (ie: ensuring effectiveness of the health care system) by formalizing agreements to refer patients to appropriate and specialized facilities).

guidelines, involving timely stabilization of patients and referring more severe and complex cases to highly specialized tertiary care centres.

Study methods that do not include transferred patients, or that evaluate outcomes separately for transferred and non-transferred patients may be less suitable for current health care systems that have established specialized tertiary care centres, with supra-regional mandates (in other words, centres that are mandated to treat patients admitted from other regions, in the context of regionalized health care systems). Efforts to make health care systems more efficient include developing resources in specific hospital centres and establishing referral lines to those centres from other hospitals. In this way, the volume of procedures conducted in select centres will contribute to the maintenance of skills and competencies that are associated with desirable outcomes (59).

When AMI patients are transferred, the role of the referring hospital is to stabilize patients and to transfer those who need invasive revascularization interventions to adequately equipped tertiary care centres (140) (Appendix 2). Timeliness in providing appropriate interventions is an important determinant of the outcomes of care for AMI patients (141;142). The risk of in-hospital death has been found to be nearly two times higher in transferred medical and surgical patients than in direct admissions (143). Patients who are transferred between hospitals therefore pose specific challenges in comparative hospital studies that have been not dealt with consistently to date (144).

Some studies have used each hospital admission as the unit of analysis, meaning that patients who were transferred between facilities for the treatment of the same episode of AMI were counted twice in the study (118). Problems arise when using this approach. The mortality rate of the referring hospital is underestimated because transferred patients are

always discharged alive, regardless of their eventual outcome. On the other hand, the mortality rate of the receiving hospital may be overestimated because tertiary cardiovascular care centres (rescue hospitals) are more likely to receive sicker patients, with no opportunity to provide quality care during the critical time period for AMI patients (124).

Other studies have excluded all transferred patients from their analyses (88;109). However, these exclusions may result in a limited perspective of the overall quality of care provided by hospitals that deal with a high volume of transferred AMI patients. Inter-hospital transfers may have poorer risk adjusted outcomes and may require more intense resources than patients who are admitted directly (143;145). Excluding these patients from comparative performance studies may introduce bias by underestimating the overall level of severity of patients admitted to rescue hospitals and the overall use of available resources, while not crediting these hospitals for high quality care that may have saved these high-risk patients.

Lastly, studies that have included transfers have had to reconstruct entire episodes of care through record linkages (52;146). An important question posed here is "to which hospital should the outcome of care be attributed?" Studies that have included transfers and that have attributed the outcome of care to the first admitting hospital in each episode of care (114;116) may have penalized the referring hospital for poor follow up care provided subsequent to the patient's transfer. Other studies that have included transfers have conducted separate analyses for transferred patients and for those admitted directly to hospital (119), but this approach does not allow us to gain an overall perspective of the quality of AMI care provided by rescue hospitals.

To date, there have been no reports of the impact that transfers may have on hospital performance profiles and ranks. Yet in light of the large fraction of transferred patients in some types of hospitals (Table 1-2) and the inconsistencies in the methods used to deal with these patients, a better understanding of the relationship between the methods adopted and the hospital performance profiles will help guide future comparative outcome studies.

Adjustment factors

Patient characteristics

Table 2-3 outlines the various patient characteristics that have been included in hospital performance comparison studies.

Age

Age is an important variable to consider adjusting for since some hospitals may be more likely to admit older patients, and older patients are also more likely to die of an AMI (147;148). Although not explicitly tested for in most hospital performance studies, differences in age distributions across communities, neighbourhoods or urban/rural regions (149) may lead to age differences among hospitals located in these communities, neighbourhoods or urban/rural regions.

Most comparative hospital performance studies using AMI mortality as an indicator have therefore included age as a confounding variable. Age has been included in multivariate regression models as either a categorical (6;69;71;116) or continuous (89;115;118) variable, depending on the source of the data used, where publicly available administrative datasets

tend to use age categories as one of several measures to ensure individual patient confidentiality. Performance evaluation studies that compare hospital mortality rates among AMI patients, have typically limited the study population to adults only or to patients who are 65 years of age or older (5;6;69;71;107;109;115;116;118;136;150) due to the nature of the data source used for studies. For example, Medicare is a US Health Insurance Program available to people 65 years of age and older, some disabled people under 65 years of age, and people with End-Stage Renal Disease (ESRD) (151), therefore studies using these data need to restrict the study population based on age criteria (109;110).

Gender

While higher mortality rates during AMI hospitalizations have been noted in women as compared with men, these gender-based differences varied with age; specifically, women died at a younger age than men (152). Based on a review conducted by Feldman and Silver (153), underlying factors that may explain these differences include: greater delays in presentation among women, differences in healthcare provider types, and differences in the diagnostic and therapeutic interventions selected for men versus women. As with age, the variation of gender across hospitals has not been explicitly illustrated in hospital performance studies, yet gender has been included as a covariate in a number of studies that compare AMI hospital mortality rates (109).

Comorbidity

A longstanding concern regarding the validity of comparative hospital mortality studies is whether the severity of a patient's condition and the resulting risk of death have been taken into account (154). Referral patterns can result in higher mortality rates for hospitals that treat sicker patients (155). These patterns of referral can introduce bias in

comparative hospital performance studies if patients with a higher risk of mortality are selectively admitted to specific hospitals. As a result, several risk adjustment methods have been developed and reviewed (64;156-159).

The importance of risk adjustment in hospital performance studies has prompted researchers to review a number of available risk adjustment methods (Table 2-4). While risk adjustment models that use clinical data (160-162) generally perform better than models based on administrative databases (159;163-167), studies using the former type of data are very expensive and time-consuming to carry out (159). In fact, a number of states have stopped using risk adjustment methods that rely on clinical data due to the high costs involved (148). In addition, some of these tools adjust for the severity of comorbidities using information based on the amount of resources used during hospital admissions, and although useful for performance studies that compare hospital efficiency in resource use, they may be limited in their application to studies that compare mortality rates (166). Hence, unless specifically developed clinical databases are available, hospital performance studies rely on routinely collected hospital discharge databases, and risk adjustment methods using these data are applied (159;163-167).

The Charlson co-morbidity index is readily available at no cost to the user, and has therefore been used extensively in the literature. This comorbidity index was developed for the purpose of estimating the risk of death from comorbid diseases listed in the medical chart (165). The Charlson Index was subsequently adapted for use with administrative data that recorded ICD-9-CM diagnoses (167). Romano and colleagues independently adapted the Charlson Index for use with administrative databases and proposed a slightly different list of codes than did Deyo

and colleagues (168), although the predictive power of both these indices are similar (169).

Socioeconomic status (neighbourhood)

Socioeconomic status (SES) can influence access to health care services, which may in turn affect health outcomes (39;42). However, information on the level of education and income (components of SES) is not readily available at the individual level and this information has to be gleaned from aggregate data, usually available at the neighbourhood level (170). Therefore, SES measures that have been used in health care comparative evaluation studies have been area-based. Variables used to measure socioeconomic status have included neighbourhood income levels, stratified into quintiles (32), proportion of individuals in a neighbourhood who are unskilled workers or who are unemployed (171), median neighbourhood income (172), and the proportion of the population, in a specific geographic area, with a household income falling below the low income cut-off (173).

The use of area-based SES measures assumes homogeneity in individual SES within each area. However, researchers have found that area-based measures of SES are poorly correlated with individual measures of SES (174). Using neighbourhood SES as an indicator of individual SES would most likely lead to a differential misclassification, where individuals of higher SES may live in areas of lower SES, since poorer individuals would unlikely afford dwellings in richer areas. This exposure misclassification would attenuate the relationship between mortality and SES, where individuals of high SES and low mortality would be misclassified as individuals of low SES with low mortality.

Yet, despite the attenuated effects of neighbourhood SES on health outcomes, this area-based variable continues to be studied in the context of social inequalities of health outcomes and access to health. Attributes that have been used to estimate area-based measures of socioeconomic status (SES) include: income, employment, educational attainment, and social characteristics (52). Several researchers have studied the association between area-based socioeconomic status indicators with the health of individuals, in order to identify the determinants of health or to assess disparities in health between various groups in the population. For example, problems of access to primary care were associated with living in lower income areas, which may in turn affect health outcomes (38). Also, despite the universal health system in Canada, Ontario researchers have found that the median income of the residential neighbourhood where patients live, based on 1996 census data, was positively associated with access to specialized cardiac services and negatively associated with mortality within 1 year following an AMI (7;175). Researchers in Manitoba also found that the health of the population varies with socioeconomic status (32), reporting that people living in neighbourhoods with higher median household incomes have better health.

Geographic location

Factors such as the distance to the nearest emergency facility and the distance to the nearest cardiovascular tertiary care centre can represent disparities in the time required for AMI patients to access appropriate care. Like in many Canadian provinces, Quebec's geography has contributed to a variation in the average time needed to reach a hospital centre (176). Hence, severely ill patients in rural areas may be more likely to die before reaching hospital, whereas equally ill patients in urban centres may reach a hospital alive, but die shortly thereafter. There may therefore be a survivor bias among urban hospitals, whose patients have a better chance

to arrive to hospital alive but also have a greater risk of dying in the hospital because they are severely ill. In the absence of clinical details available from medical charts, few studies based on administrative databases have accounted for distances that needed to be travelled to get to tertiary care facilities (177) and for the urban status of the hospital location (105;178).

Hospital characteristics

Hospital characteristics included in comparative studies are outlined in Table 2-5.

Hospital Volume

Research findings have suggested that there is a relationship between a hospital's volume of activity and outcomes of the care it provides, but findings have not been consistent. For example, some studies have found that in-hospital mortality rates were significantly lower in hospitals performing high volumes of CABG than in other facilities (179;180) while other studies found no such relationship (181). It is important to note, however, that higher-volume hospitals may also have shorter average post-operative lengths of stay (180), which may have a confounding effect on in-hospital mortality comparisons, since patients who leave the hospital cannot die in-hospital. Ferguson and colleagues (182) reported similar inconsistencies in their review of the literature on the volume-outcome relationship for other cardiac procedures and for AMI patients (183-187).

A subsequent review (188) highlighted a number of issues underlying the study of the volume-outcome relationship that may, in part, explain inconsistent findings in this area of study. Less than a quarter of the studies reviewed by the authors used adequate risk adjustment methods,

which may have resulted in biased results. In fact, when appropriate adjustment methods were applied, the higher risks associated with low volume hospitals were attenuated. Also, most studies were cross sectional, and the authors concluded that this type of study made it difficult to show that quality could improve if smaller hospitals increased their volume over time, which would support the volume-outcome relationship. Lastly, in-hospital mortality may not be an appropriate outcome to use in such studies because it does not consider deaths after discharge and may therefore reflect differences in discharge practices, rather than differences in outcomes attributable to the volume of care provided by a hospital.

Despite these inconsistent findings in the literature, some comparative hospital performance studies have included hospital volume (measured as the number of AMI admissions or patients treated per time period) (69;118;150) or hospital size (measured as the number of beds in the hospital) (89;105;109;112;116).

Revascularization facilities

Although studies have reported that AMI patients were more likely to undergo invasive procedures when admitted to facilities equipped to perform onsite coronary revascularization than when admitted to unequipped facilities, mortality rates were not consistently found to vary according to this hospital characteristic (138;177;183;189). Alter et al. reported significant differences between the two groups of hospitals in terms of patient characteristics (average household income, clinical status, predicted 30-day mortality) and processes of care (invasive procedures performed during index hospitalization, time from index AMI admission to invasive procedure, length of hospital stay) (177). Despite inconsistent findings regarding the confounding effect this hospital characteristic may

have in performance evaluations, it is rarely included in comparative studies (116).

Teaching status

Hospital teaching status has been included in several hospital performance evaluation studies (106;107;112;116;179). In a recent review of the literature addressing the relationship between hospital teaching status and quality of care (190), issues that merit consideration are highlighted, such as the method used to define a hospital's teaching status. While teaching hospitals are responsible for providing education and research, flagship or university-affiliated hospitals may have a more supportive role in these functions. It is therefore important to distinguish between these two types of hospitals. Among studies that met the reviewers' methodological criteria, 30-day mortality among AMI patients was found to be lower in major teaching hospitals than in other hospitals (107;191;192).

Other factors

Health system factors

Despite controversies in the matter of the relationship between AMI mortality rates and hospital characteristics (such as volume, teaching status, and size), jurisdictions have adopted national guidelines for annual cardiac procedure volumes (193) as a means to achieve high quality care and to attain economies of scales (194). This trend may also have been stimulated by the advancement of science that has resulted in the uptake of sophisticated health care technologies (195). Faced with spiralling costs associated with the advent of these complex technologies, provincial

governments in Canada have favoured a regionalized health care structure in an attempt to optimize system-wide efficiencies (196). In Quebec, during the most recent wave of health reforms, highly specialized supra-regional tertiary care facilities called university health centres (CHU – Centre hospitalier universitaire) have been created by way of university hospital mergers (173). During this same era of reforms there has been a reorganization of human resources and efforts to define corridors of service (197).

Hospital performance studies are typically cross-sectional (71;88;105-107;109;112). It is therefore difficult to understand the influence of these system level changes on hospital performance levels over time. Longitudinal studies in Quebec (137;195;198) and in Ontario (199), have demonstrated a reduction in death rates over time, attributing this trend primarily to technological advancements. Hospital performance studies that rely on a single year of data may reflect the impact of these changes on hospital outcomes. By including several years of data in comparative evaluation studies, results can therefore reflect more stable estimates of hospital performance levels, that are less likely to be vulnerable to fluctuating health system level factors and to random variation in mortality rate estimates.

Source of data and data accuracy

Data acquired from medical chart reviews have a higher level of accuracy than those acquired from administrative databases (200). However, a trade off may need to be made between the substantial expense associated with data extraction and the errors encountered in administrative data (190;201). More important, if these errors are not systematically associated with specific hospitals, they represent an

undifferentiated measurement error that may reduce the precision of results, without introducing bias. In studies that use national or provincial databases, the undifferentiated measurement error can be countered by the power gained using large sample sizes in these databases.

While there may be concerns regarding the coding accuracy for diagnoses in administrative databases, a Quebec study has reported a positive predictive value for coding AMI of 0.96 (95% CI 0.94, 0.98). In other words, the probability that a patient with an AMI diagnosis coded in the provincial hospital discharge database actually had an AMI diagnosed by the discharging physician was 96% (200).

The cause of death indicated on the death certificate is susceptible to coding inaccuracies that are well documented and have been shown to depend on the physician completing the certificate (202). Physicians are likely to work in specific hospitals; therefore these systematic errors can be transferred to the level of hospitals. On the other hand, inaccuracies regarding the ascertainment of death are unlikely. Hence, by using all cause deaths as an outcome of interest in hospital performance studies, inaccuracies are less likely to be differential across hospitals. Furthermore, death certificates for most AMI patients admitted to acute care hospitals in Quebec who died within 30 days of the index admission indicate the cause of death to be a cardiovascular condition (Table 2-6).

Conclusion

The repercussions of comparative hospital performance studies are important. Invalid results can lead to unfounded judgement of hospitals and to unwarranted changes in health care delivery. Such changes can in

turn have harmful effects on the quality of care or, at best, can waste scarce resources.

Despite the importance of taking necessary measures to ensure confidence in the results obtained from hospital performance studies, the literature reviewed in Chapter 2 has pointed out that there are inconsistencies in:

1. Time frames used for outcome evaluation
2. Patient selection criteria
3. Patient-level adjustment factors
4. Hospital-level adjustment factors
5. Other factors

This study will focus on the first two areas named above where methods have been inconsistent in the literature.

Objectives

Purpose of this project:

The overall purpose of this study is to estimate the extent to which the methods used to define the time frame for outcome evaluation and the methods used to select AMI subjects impact on hospital performance ratings.

Specifically the objectives are:

1. To estimate the extent to which the time frame for AMI outcome evaluation impacts on hospital performance ratings.
2. To estimate the extent to which the inclusion/exclusion of transferred AMI patients impacts on hospital performance ratings.

Tables and Figures pertaining to Chapter 2

Table 2-1: Timeframes used to define outcomes evaluated in comparative hospital performance studies

	Reference	Year of study	Time frame used for outcome evaluation
Scientific Literature	Severity-adjusted mortality and length of stay in teaching and nonteaching hospitals. Results of a regional study. (107)	1997	In-hospital deaths
	Population-wide mortality trends among patients hospitalized for acute myocardial infarction: the Ontario experience, 1981 to 1991. (71)	1994	In-hospital deaths
	Interhospital variations in admission severity-adjusted hospital mortality and morbidity. (88)	1991	In-hospital deaths (Admission severity-standardized mortality)
	Risk-adjusted in-hospital death rates for peer hospitals in rural and urban regions.(105)	1999	In-hospital risk-adjusted mortality
	The ratio of observed-to-expected mortality as a quality of care indicator in non-surgical VA patients. (104)	1994	Deaths within 30 days of admission
	Hospital Outcomes in Major Teaching, Minor Teaching and Nonteaching Hospitals in new York State. (106)	2002	In-hospital deaths
National Studies	The Cooperative Cardiovascular Project in Oklahoma. (109-111)	1997	In-hospital deaths and 30-day post-discharge deaths
	Interpreting the Health Care Financing Administration's Mortality Statistics (112)	1995	Deaths at 30, 90, 180 days after admission.
	Haygroup Study (91;126)	1998	In-hospital deaths
State and Provincial Studies	Focus on Heart Attack in Pennsylvania (117-119)	1996	In-hospital deaths
	Cardiovascular Health and Services in Ontario (116)	1999	Deaths at 30-days & 1-yr post-AMI (Deaths attributed to 1st admission when patient was transferred)
	California hospital outcomes project - Report on Heart Attack (113-115)	2002	Deaths at 30-days post-AMI (Deaths attributed to 1st admission when patient was transferred)
Health System Performance Assessment Frameworks	NHS Performance Indicators: July 2000 (136)	2000	Deaths at 29 days post-admission
	Agency for Healthcare Research and Quality (AHRQ) (5)	2002	In-hospital deaths
	CIHI - Health Care in Canada (6-8;134)	2002	All cause in-hospital deaths within 30 days of AMI admission

Table 2-2: AMI index admission characteristics included in comparative hospital performance studies

Reference	Admission source and type included	Transfers	LOS (Length of Stay)	Exclusions (not elsewhere described)
Severity-adjusted mortality and length of stay in teaching and nonteaching hospitals. Results of a regional study. (107)	1. Home or nursing home 2. Admitted through emergency or not	Excluded patients transferred in from another acute hospital	Included LOS as a confounder in the regression model	Patients with "DNR" (do not resuscitate) orders were excluded
Population-wide mortality trends among patients hospitalized for acute myocardial infarction: the Ontario experience, 1981 to 1991. (71)			Excluded patients with LOS < 4 days if the patient was discharged alive (all deaths were included)	Patients who signed themselves self out were excluded. Excluded patients with AMI within 3 months prior to index admission
Interhospital variations in admission severity-adjusted hospital mortality and morbidity. (88)		Transfers were excluded		
Risk-adjusted in-hospital death rates for peer hospitals in rural and urban regions. (105)		Patients transferred to another short-term hospital were excluded. Patients who were transferred but who died shortly after transfer were included in the receiving hospital's mortality rate	Included patients with LOS > 1 day if patient was discharged alive (all deaths were included)	
The ratio of observed-to-expected mortality as a quality of care indicator in non-surgical VA patients. (104)	Included transfers from nursing home			Patients with "DNR" (do not resuscitate) orders were excluded
Hospital Outcomes in Major Teaching, Minor Teaching and Nonteaching Hospitals in new York State. (106)	1. Emergency admissions 2. Patients transferred in	Transfers were included in study	LOS was modelled as one of the outcomes compared	
The Cooperative Cardiovascular Project in Oklahoma (1997) (109;111;203)	1. Nursing home 2. Long term care hospital 3. Home	Transfers were excluded from the study		
Interpreting the Health Care Financing Administration's Mortality Statistics (1995) (112)	1. Physician referral 2. Skilled nursing facility 3. Elective or emergency admissions			Excluded patients with a hospital discharge within 3 months prior to index admission

Haygroup Study (1998) (91;126;127;204)		Patients transferred out were excluded	LOS was one of the outcomes compared across hospitals	
Focus on Heart Attack in Pennsylvania (1996) (117-119;205-208)	1. Physician referral 2. Transfer from acute care hospital 3. Skilled nursing home 4. Another health care facility (eg: rehab) 5. Other (clinic referral etc) 6. Emergency/urgent/elective admissions	Patients with 2 or more transfers were excluded. Transfers were analyzed separately.		
Cardiovascular Health and Services in Ontario (1999) (116)	No AMI in year prior to admission AMI not coded as a complication	Included only the first admission and attributed outcome to the first admission.	Included patients with LOS > 3 days if patient was discharged alive (all deaths were included)	
California hospital outcomes project - Report on Heart Attack (2002) (113-115)	1. Home 2. Residential care facility 3. Ambulatory surgery 4. Other (nonacute) inpatient hospital 5. Prison/jail 6. Other	Included only the first admission and attributed outcome to the first admission.	Included patients with LOS > 3 days if patient was discharged alive (all deaths were included)	
NHS Performance Indicators: July 2000 (136)	Identified emergency admissions	Continuous inpatient (CIP) spells included transfers		
Agency for Healthcare Research and Quality (AHRQ) (5)		Excluded patients transferred to another short-term hospital		
CIHI - Health Care in Canada 2002 and supplemental documents (6-8;134)		Included same day transfers	Excluded patients with LOS 3 or more days if patient was discharged alive (all deaths were included)	

NOTE: Blank cells represent information for which no specific information was provided.

Table 2-3: Patient characteristics included in comparative hospital performance studies

	Reference	Year of Study	Age	Gender	Comorbidities (methods used for adjustment)	SES
Scientific Literature	Severity-adjusted mortality and length of stay in teaching and nonteaching hospitals. Results of a regional study. (107)	1997	Included over 18 only		Authors developed their own model, including clinical data recorded at time of admission	
	Population-wide mortality trends among patients hospitalized for acute myocardial infarction: the Ontario experience, 1981 to 1991. (71)	1994	20 < age < 105 Included as a categorical variable	x		
	Interhospital variations in admission severity-adjusted hospital mortality and morbidity. (88)	1991			DRGs (Diagnostic Related Groupings) supplemented with ASG (admission severity groups) obtained from manually extracted data recorded on file within 48 hrs after admission.	
	Risk-adjusted in-hospital death rates for peer hospitals in rural and urban regions.(105)	1999	X	x	Presence of a secondary diagnosis and presence of CA as a secondary diagnosis	
	The ratio of observed-to-expected mortality as a quality of care indicator in non-surgical VA patients. (104)	1994	X		Incorporated in the logistic regression model to predict mortality	
	Hospital Outcomes in Major Teaching, Minor Teaching and Nonteaching Hospitals in new York State. (106)	2002	X	x	Deyo version of Charlson	
Scientific Literature related to other heart conditions/ procedures	Chance, continuity, and change in hospital mortality rates. CABG patients in California hospitals, 1983 to 1989. (150)	1993	Included 18 yrs and over	x	Chronic comorbidities	
	Inter-hospital mortality and morbidity variation in Pennsylvania (89)	1993	Included as a continuous variable	x	DRGs (Diagnostic Related Groupings) supplemented with ASG (Admission Severity Group)	
	Coronary artery bypass mortality rates in Ontario. (69)	1996	Included as a categorical variable	x	Charlson Index supplemented with selected clinical risk factors recorded in special provincial dataset	
National Studies	The Cooperative Cardiovascular Project in Oklahoma. (109-111)	1997	> 65 (Medicare database)	x	APACHE II (proprietary system based on clinical data) Supplemented with information on site of infarct.	
	Interpreting the Health Care Financing Administration's Mortality Statistics (78;78;112)	1995	x	x	12 categories of single or combinations of comorbidities	
	Haygroup Study (91;126)	1998	All age groups included		CMG (Case Mix Groupings). Supplemented with "Complexity Overlay" severity information based on resource use and other information	

Table 2-3: Patient characteristics included in comparative hospital performance studies						
	Reference	Year of Study	Age	Gender	Comorbidities (methods used for adjustment)	SES
State and Provincial Studies	Focus on Heart Attack in Pennsylvania (117-119)	1996	Included in model as continuous variable Restricted to 30-99	X	Own model	
	Cardiovascular Health and Services in Ontario (116)	1999	Included in model as categorical variable Restricted to 20-105	X	Own model	
	California hospital outcomes project - Report on Heart Attack(113-115)	2002	Included in model as continuous variable Restricted to 18yrs or older	X	Own model, supplemented with information on site of infarct.	
Performance Assessment Frameworks	NHS Performance Indicators: July 2000 (136)	2000	Ages 35-74	X		
	Agency for Healthcare Research and Quality (AHRQ) (5)	2002	18 yrs and older		APR DRG (all patient refined - diagnostic related groupings)	
	CIHI - Health Care in Canada (6-8;134)	2002	Ages included: 20-105 Included as a categorical variable	X	Specific comorbidities noted, including: CHF, acute diabetes, anemia	

"x" indicates the variable was included in the study's analysis

Table 2-4: Reviews of Risk Adjustment methods used for comparative hospital performance studies

Review Reference	Outcome used for review	Method	Data Source	Statistical performance of the model[7]
Iezzoni et al. (64)	All-cause in-hospital mortality	MedisGroups (88;162)	Clinical data	0.83
		Apache II (160)	Clinical data	0.82
		Apache III (161)	Clinical data	0.83
		Disease Staging (163)	Administrative data (clinical definition of severity)	0.86
		Patient Management Categories (164)	Administrative data (clinical definition of severity)	0.82
		Charlson Comorbidity Index (165)	Administrative data (clinical definition of severity)	0.70
		APR-DRGs (166)	Administrative data (resource-based definition of severity)	0.84
		R-DRGs (166)	Administrative data (resource-based definition of severity)	0.80
Tu et al. (159)	AMI 30 day mortality	Ontario AMI mortality prediction rule (159)	Administrative data	0.78
		Deyo Adaptation of Charlson Index (167)	Administrative data	0.74
Iezzoni (157)	AMI and 3 other Diagnoses	MedisGroups (162)	Clinical data	0.83
		Physiology Score	Clinical data	0.83
		Disease Staging (163)	Administrative data	0.86
		PMC Severity Scale (164)	Administrative data	0.82
		APR-DRGs (166)	Administrative data	0.84

[7] A model's discriminative ability can be assessed using the area under its Receiver-operating characteristics (ROC) curve, which is measured using the c-statistic[7] (250). The c statistic is a measure of rank correlation that can be used to judge a model's fit. A perfect model would have the c statistic = 1.0 while a value of 0.50 indicates no relationship between the explanatory variables and the dependent variable (89). This statistic represents, for all comparisons of patients who lived and who died, the proportion of times that patients who died had a higher predicted risk of death (251).

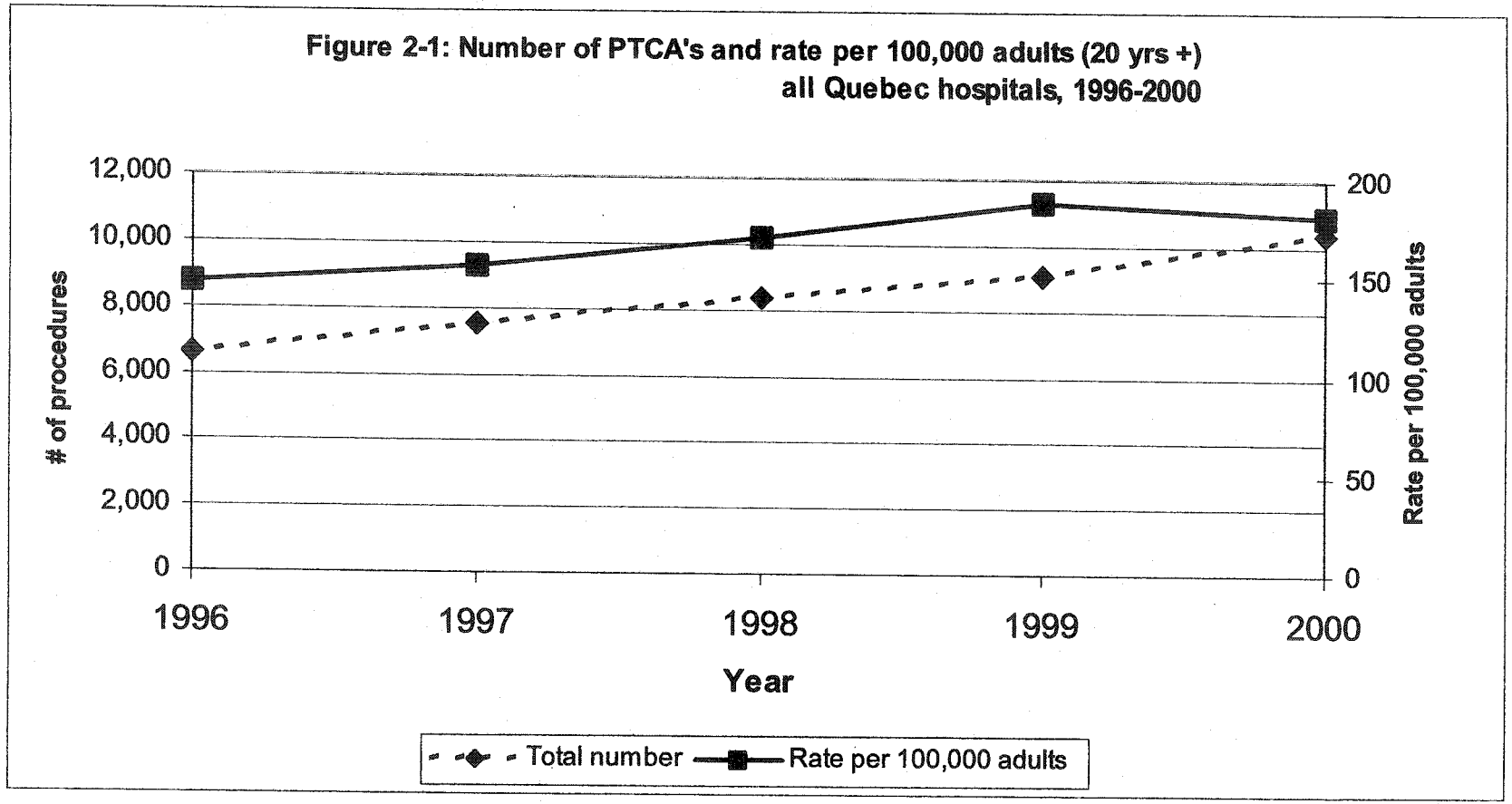
Table 2-5: Hospital characteristics used in comparative performance studies

	Reference	Year of Study	Hospital Volume	Revascularization Facilities	Teaching Status
Scientific Literature	Severity-adjusted mortality and length of stay in teaching and nonteaching hospitals. Results of a regional study. (107)	1997			Major, minor and non-teaching hospitals
	Risk-adjusted in-hospital death rates for peer hospitals in rural and urban regions. (105)	1999	Size of hospital		
	Hospital Outcomes in Major Teaching, Minor Teaching and Nonteaching Hospitals in new York State. (106)	2002			Major teaching, minor teaching, nonteaching
Scientific Literature (comparative studies related to other heart conditions or procedures)	Chance, continuity, and change in hospital mortality rates. CABG patients in California hospitals, 1983 to 1989. (150)	1993	Volume was an inclusion criteria for hospitals included: a minimum volume of 5 CABG in any year during study		
	Inter-hospital mortality and morbidity variation in Pennsylvania (89)	1993	Hospital size hospitals with < 100 beds were excluded		
	Coronary artery bypass mortality rates in Ontario. (69)	1996	Stratified results according to hospital volume		
National Studies	The Cooperative Cardiovascular Project in Oklahoma. (109-111)	1997	Small rural; Small urban; Medium urban; large		
	Interpreting the Health Care Financing Administration's Mortality Statistics (78;112)	1995	Bed size		Included in the model
	Haygroup Study (91;126)	1998			Study was restricted to teaching hospitals
State and Provincial Studies	Focus on Heart Attack in Pennsylvania (117-119)	1996	Volume		
	Cardiovascular Health and Services in Ontario (116)	1999	Hospital bed size; volume of cardiac patients (exclude hospitals with < 30 patients over 3 yr period)	Type of hospital	Included

Table 2-6: Cause of death among patients who died within 30 days post-AMI admission, Quebec acute hospitals 1992-1999

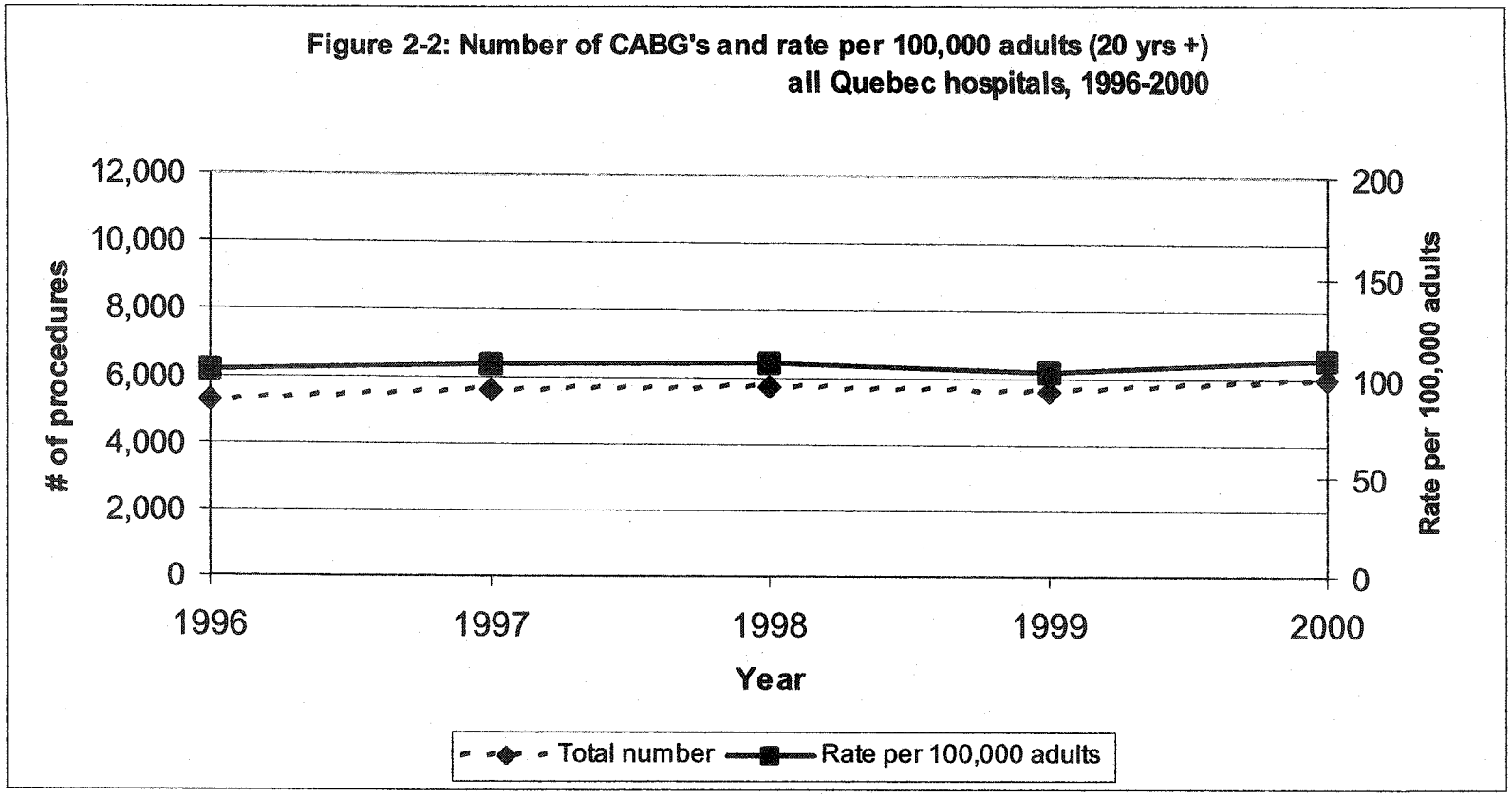
Cause of Death	Patients who died within 30-days of index AMI admission (n, %)	
Cardiovascular deaths	10426	*87%*
Other	1575	*13%*
Total	12001	*100%*

Figure 2-1: Number of PTCA's and rate per 100,000 adults (20 yrs +), all Quebec hospitals, 1996-2000
Source: Quebec RAMQ and Med-Écho Databases



	1996	1997	1998	1999	2000
Total number	6,615	7,525	8,389	9,111	10,383
Rate per 100,000 adults	145.54	154.92	169.55	187.73	182.07

Figure 2-2: Number of CABG's and rate per 100,000 adults (20 yrs +), all Quebec hospitals, 1996-2000
Source: Quebec RAMQ and Med-Écho Databases



	1996	1997	1998	1999	2000
Total number	5,251	5,561	5,696	5,568	6,000
Rate per 100,000 adults	103.00	106.33	106.92	103.13	108.91

Chapter 3 METHODS

Source of Data

The data used for this study were obtained from two sources. The first was Quebec's provincial hospital discharge database, Med-Écho ("système de maintenance et exploitation des données pour l'étude de la clientèle hospitalière"). Information contained in this administrative database comes from medical records of all patients discharged from Quebec hospitals. Medical archivists review these patients' medical charts and use established coding procedures to abstract the information onto the required form. (A copy of this form is attached in Appendix 3). Med-Écho staff verify the data regularly (209) and corrections are made to ensure database records correspond with hospital charts (27).

The second source of data was the Quebec provincial vital statistics database, containing information from all death certificates in Quebec (Appendix 4). Unique identification numbers, which assured patient anonymity, were used to link individual records for patients having information in both these databases. InfoCentre, the Quebec agency mandated to manage all provincial databases related to the Ministry of Health and Social Services, performed this linkage after the investigators obtained approval from the Commission d'accès à l'information (CAI) du Québec. The application review process is designed to ensure that linking database records of otherwise anonymous data sources cannot allow investigators to identify individual patients without their explicit consent (Appendix 5).

The main advantage for using these databases to evaluate hospital performance is that they contain adequately large amounts of data to provide sufficient statistical power to detect small differences in important outcomes such as mortality rates. The main disadvantage is that these data sources do not contain detailed clinical information, other than diagnoses and medical procedures.

Study Population

Figure 3-1 illustrates the study population used in this study. Data were requested from the Quebec Ministry of Health and Social Services (Ministère de la santé et des services sociaux – MSSS). Records were requested for all patients admitted to an acute care hospital in Quebec between 1992 and 1999, who were 18 years or older, and residents of Quebec. Patients admitted to paediatric, psychiatric and inpatient rehabilitation hospitals were excluded, leaving 295,000 admission records in the database.

Identifying Index AMI Admission

To respect the assumption of independent observations, a single index AMI admission was selected for each patient in the dataset. An index AMI admission was defined as the first AMI admission that occurred during the study period (1992 to 1999) for which there was no previous AMI admission in the year prior. There were 94,592 index admissions identified in the database.

There were 6 patients (corresponding to 6 index AMI admissions) removed from the dataset, for whom the date of death in the vital statistics

database occurred before the index admission date, and for whom there was no date of death indicated in MedEcho.

Without having medical records available to verify the information contained in administrative databases, an important component in making an administrative dataset ready for analysis is to ensure that the appropriate observations are included in the study. A number of additional exclusion criteria have therefore been applied in various hospital performance studies that compare AMI mortality rates.

Misclassification of the final diagnosis may result in a selection bias, if certain hospitals systematically miscode diagnoses and systematically admit atypical patients (that is, patients that are more or less likely to die). Admissions during which an AMI diagnosis was suspected but subsequently ruled out may have nonetheless been assigned a final diagnosis of AMI. Leaving these admissions in the dataset may deflate the mortality rate, and if this situation is systematically different across hospitals, bias can be introduced. Therefore, 772 admissions during which patients were discharged home alive after a length of stay of one day or less were removed from the dataset (116).

Clinical information is usually limited in most administrative databases used for hospital performance studies. Although some jurisdictions have expanded their administrative systems to include considerable clinical information (such as vital signs at time of admission, medications dispensed during the admission, and laboratory results) these databases are often expensive to develop and maintain (148). When using administrative databases, variables such as the type of admission can be used as a proxy variable for the patient's severity of illness. Therefore, researchers have restricted AMI hospital performance studies to urgent admissions (116). The Quebec Med-Écho database classifies admission

type categories as emergency, semi-urgent, elective (non-urgent), and obstetric admissions (209). Nearly 99% of the index AMI admissions in this dataset were identified as being urgent; 1,198 admissions that were not classified as urgent were removed (Table 3-1).

Patients admitted to hospital can experience an AMI as a complication of the initial diagnosis and may not receive the same process of care as a patient admitted for an AMI (116). Med-Écho provides a 2-digit suffix to identify final diagnoses that are complications of another condition (209). Using this code, 247 admissions were excluded. Similarly, index admissions that were immediately preceded by a non-AMI admission in another hospital may have been admissions for complications for other diagnoses. An additional 736 admissions were therefore removed for this reason. In other words, only AMI patients admitted directly from home or a non-acute care facility were included in this study (106;107;109;111-113;136;203).

The final dataset consisted of 91,633 patients admitted for an index AMI admission. These included 13,520 patients who were subsequently sent to another hospital. Of these, 10,395 patients were transferred to another hospital for care and 3,125 were sent to another hospital for a procedure during their index AMI admission. Of those who were sent for a procedure, 2,574 were discharged home or to a non-acute care facility after they returned to the initial (index admission) hospital, whereas 551 were transferred to another hospital after they returned to the initial hospital.

Constructing Episodes of care

As is the case for most administrative hospital databases, the initial structure of this dataset consisted of a separate record for each admission. This type of file structure does not allow investigators to easily track each patient's course of treatment when it consists of more than a single admission. Episodes of care therefore needed to be constructed by linking individual admission records for each patient (146). Records were linked in chronological order using several variables: an encrypted unique patient identifier, the date of admission, and the date of discharge (because patients could be admitted and discharged on the same day and this for more than one hospital at a time, the data were also sorted on the admission-specific variable "death", that denoted whether or not the patient died in hospital during that admission). The following algorithms were developed for this record-linking process and are illustrated in Appendix 6.

For each eligible patient, the first episode of care began with an *index AMI admission*. (An index AMI admission was defined as the first AMI admission that occurred during the study period and that was not preceded by a previous AMI admission in the year prior).

If, following the index admission, the patient was not readmitted during the study period, the index admission was tagged "***No Return***" (Scenario A).

In some instances, AMI patients are admitted to one hospital but are subsequently sent to another hospital for a specialised procedure. Hospitals sending patients to another hospital may administer the admission record in one of two ways. The referring hospital may keep the patient in its books until the patient returns from the specialized cardiac facility to complete the hospital stay at the initial hospital. This admission

type was identified as a "***Procedure***" (Scenario B). Alternatively, the referring hospital may discharge then readmit the patient after the specialized cardiac procedure, for which the admission type was identified as a "***Transfer***" (described below). It should, however, be noted that, regardless of which administrative procedure was applied by the hospital (keeping the patient on the books or discharging then re-admitting), both scenarios described above (procedures and transfers) involve an inter-hospital transfer for the patient and should be considered a transfer.

An admission was identified as a "***Transfer***" when the patient was discharged from one hospital and admitted to another hospital within 1 day (Scenario C). An admission could also be identified as a "***Transfer with Adjustments***" when the patient's admission pattern followed the sequence of an admission to the initial hospital, followed by a second admission to another hospital, discharged from the first hospital, then subsequently discharged from the second hospital (Scenario D). The "adjustments" consisted of revising the date of discharge from the first hospital and the length of stay during the first admission. The admission was thereafter considered a "***Transfer***".

Although outcomes other than death were not studied, creating the episodes of care made it possible to define two additional admission scenarios. When a patient was discharged from one hospital then readmitted within 2 to 30 days following the discharge, the admission type was identified as a "***Readmission***" (Scenario E). However, if the patient was discharged from one hospital and subsequently re-admitted to any hospital after 30 days following the previous discharge, the admission type was identified as the start of a "***New episode of care***" (Scenario F). Unlike other studies that included these "new episodes" in their analyses, this study excluded them in order to ensure that each unit of analysis (index AMI admission) was independent of others (124).

Research Design

A cohort study design was used to identify index admissions for all AMI patients admitted to Quebec acute hospitals between 1992 and 1999. Mortality outcomes described below were then ascertained for the entire study population. Methodological issues pertaining to hospital performance comparison studies were addressed by ranking hospitals using various approaches described in the literature. The focus of this study was placed on methodological variants pertaining to how the outcome is defined and how transfers are handled. Among nine possible combinations of approaches used to define mortality outcomes and to handle transfers, this study compares hospital rankings using three approaches to define outcomes and using three other approaches to deal with transfers (Figure 3-2).

Defining Outcomes

To compare hospital performance ranks using different methods to define outcomes, the most common approach used to handle transfers was selected, namely, AMI admissions excluding transfers. Hospital performance ranks were compared using three different approaches for defining hospital mortality outcomes:

1. In-hospital death
2. Death at 7 days following AMI admission
3. Death at 30 days following AMI admission

The outcome definition of in-hospital deaths is currently used less often than in the past, because a hospital's discharge practice may influence its

performance level. Specifically, hospitals that discharge patients prematurely may appear to perform well (patients are discharged alive) but patients who are discharged too early may actually die shortly after they are discharged from the initial hospital, yet this death would not be attributed to the initial hospital (132). Nonetheless, some evaluation studies continue to use in-hospital death as an outcome, due to limitations in the ability to link hospital discharge records with death certificates (7). Currently, many hospital performance studies are using death at 30 days following an AMI (using AMI admission date as a proxy value for the date of the AMI) (109;115;116). In addition to these two more conventional definitions for mortality outcome, this study compared hospital performance ranks using a third definition for hospital mortality outcome, namely death at 7 days post AMI. From a clinical perspective, the care provided in the days immediately following AMI is believed to have considerable influence on the outcome of the AMI episode (102), yet this time period has not been selected for AMI hospital performance studies in the past. Furthermore, the average length of hospital stay has been decreasing, whether estimated for index AMIs (Figure 1-5).

In-hospital deaths were ascertained using data from Med-Écho. Each record in this administrative database contains information pertaining to a single admission. The patient's discharge destination is recorded for each admission, and specifies information regarding where the patient went after the admission (home, to a non-acute care facility, to another hospital, or died). For patients whose destination code indicated they died in hospital, the date of discharge was used as the date of in-hospital death.

Death at 7 days and death at 30 days following the index AMI admission were ascertained by linking patient records originating from two databases (MedEcho and the Quebec Vital Statistics database) (Appendix 7).

The date of death appearing in the vital statistics database was incorrect for forty-five (45) patients, indicating that the patient had died before the first AMI admission. Six (6) of these were removed because these patients had no date of death in the MedEcho database that could be used for verification. For the remaining thirty-nine (39) patients, there were obvious errors of transcription that were corrected.

Identifying the hospital to which outcome is attributed

In the context of hospital performance studies, the mortality outcome is assigned to a hospital for each patient included in the study population. Therefore, the hospital to which a patient's mortality outcome is assigned will depend on how transfers are handled.

This study compared hospital performance ranks using different methods for dealing with transfers. To conduct this comparison, the outcome definition that is currently used most commonly, death at 30 days post-AMI admission, was selected. Using this outcome, hospital performance ranks were compared using three methods to handle transfers:

1. Exclude all patients transferred to another hospital
2. Include transfers and assign the outcome to the initial (referring) hospital
3. Include transfers and assign the outcome to the receiving hospital.

The hospital to which a patient is admitted is recorded for each admission contained in Med-Écho. Tracking patient care over time and creating episodes of care by linking single admissions records made it possible to select the hospital to which the outcome should be assigned (according to

the three methods used to deal with transfers, which were described above) (Appendix 8).

Other variables

Hospital mortality rates are influenced by several factors that fall under two major headings, patient-level and hospital-level characteristics.

It should be noted that all variables included in the six models that were used in this study were tested for confounding effects on the relationship between the hospital to which the patient was admitted and mortality. This process involved testing the relationship between each candidate covariate and death, followed by evaluating differences in these covariates among AMI patients across hospitals. The methods used and results for these tests for confounding are presented in the section entitled "Covariates included in the models" under statistical methods (page 74).

Patient-Level Characteristics

Patient level characteristics include individual patient factors that may contribute to a higher risk of death. These factors must be taken into account, otherwise hospitals that admit patients who have a higher risk of dying may be unfairly judged as having excessively high mortality rates, and vice versa.

Age

The confounding effect of age was examined in this study. Methods for testing the confounding effect of age and other covariates are described under the statistical methods section, entitled "Testing for confounding effects" on page 74.

The age assigned to each patient was the age recorded in MedÉcho, corresponding to the index AMI admission for each patient included in the study, regardless of whether or not the patient was subsequently transferred.

Gender

Each admission record in MedÉcho contains information on the patient's gender, coded as "M" for males and "F" for females. These values were re-coded as "0" for males and "1" for females. Gender[8] was tested for its confounding effects and included as a dichotomous covariate in all six analyses used in this study.

Co-morbidity

Some hospitals may treat patients who present with more complex diagnostic profiles and who are less likely to survive their admission than other hospitals. Co-morbidities are an important factor that contribute to patient case mix differences and have long been recognized as an important source for confounding in studies that compare the level of performance across hospitals (72;90). The Charlson Co-morbidity Index was introduced in 1986 to predict mortality among hospitalized breast cancer patients (165). The index was later modified by Deyo in 1992, who identified ICD-9 codes for each co-morbid condition, rendering the index applicable for studies using administrative databases (167). Deyo tested the index on lumber spine patients. Soon after, Romano-Roos presented their own adaptation of the Charlson Index (168), coding more cardio-vascular conditions than Deyo did. They linked each co-morbid condition to ICD-9 codes, and allowed for broader definitions than did Deyo for co-morbid conditions of peripheral vascular disease, diabetes and cancer. Romano-Roos' adaptation is also referred to as the Manitoba-Dartmouth

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[8] The variable was labelled "sex" in all models used in the analysis.

model and was used on a variety of patient populations, including cardiovascular patients, before being presented by the authors (210-213). The Romano-Roos adaptation of the Charlson Co-morbidity Index was therefore used in this study to account for case-mix differences attributable to co-morbidities (Appendix 9).

The co-morbidity index was calculated using the secondary diagnosis fields coded for each admission. There are up to fifteen secondary diagnoses recorded for each admission in Med-Écho using ICD-9 codes. Each secondary diagnosis coded during an admission that is also included in the co-morbidity index was assigned a designated weight (ranging from 1 to 6). These weights were summed for each admission, resulting in a score along a quasi-continuous scale.

It should be noted that some people might argue that there should not be true co-morbidity differences between AMI patients treated at different hospitals, as AMI patients are transported to the nearest hospital by ambulance. Additionally, some people may argue, based on anecdotal information, that differences in co-morbidity levels among patients admitted to different hospitals are due to differences in the quality of coding practices or due to the confounding effect of age differences between patients admitted to different hospitals. Hence, in addition to the methods used to examine the confounding effects of each covariate, described under the statistical methods section, entitled "Testing for confounding effects" on page 74, the confounding effects of co-morbidity were also tested after accounting for age. Finally, the number of co-morbidities coded in each patient's record was compared with the volume of AMI index admissions, to examine whether fewer co-morbidities may have been coded in smaller hospitals that have fewer resources.

Socioeconomic status (neighbourhood)

Information on socioeconomic status (SES) was not available on an individual basis. Instead, an SES indicator variable was obtained from Census data for the region of residence of the patient. The "incidence[9] of low income" is a variable included in Canada Census reports, and is defined as the proportion of families in a geographic area, whose household income falls below the low income cut offs. Low-income cut offs (LICO) are calculated by adding 20 percentage points to the average proportion of family income spent on basic necessities. These data are updated yearly to reflect changes in the consumer price index, and are calculated separately for different family sizes and degrees of urbanization (170). Census Canada calculates a LICO for geographic regions. The prevalence of low income is then reported by Statistics Canada for such geographic regions, including FSAs ("Forward Sortation Areas") that are designated by the first 3 digits of the postal code. By linking these FSAs to the patients' three digit postal codes included in the dataset, FSA-specific prevalences of low income were obtained from the 1996 Canada Census data (214). The variable is referred to as "low SES" for the purpose of this study and should be interpreted as follows: A "low SES" value of 25% assigned to a patient means that 25% of the people residing in that patient's FSA have a household income that falls below the LICO (Low income cut off). Therefore, the higher the value is for this variable, the lower the neighbourhood SES.

Missing "low SES" values accounted for less than 1% of any of the dataset used in this study (Table 3-2). Low SES values were missing when 3-digit postal codes that appeared in the study data did not appear in the Census

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[9] The term "incidence" is used by Statistics Canada, however, based on the definition of this term, it may have more appropriately been named the "prevalence of low income" as it represents the proportion of families in a geographic area, whose household income falls below the low income cut offs. In this thesis, the term "prevalence" will be used hereafter.

Canada list[10]. The missing data were imputed using the overall average value for the entire dataset (low SES = 24%). Given the small number of missing values, it is unlikely that using the overall average would lead to substantial bias or underestimation of the variation in the data, which is an issue raised by several authors (215).

Distance to nearest tertiary cardiac care facility

Clinical guidelines for cardiac care advocate timeliness and availability of appropriate care for AMI patients. Patterns of care provided are often dependent on the delay between the onset of the AMI and treatment initiation (Appendix 10). Patients transported to hospital within 6 hours of symptom onset can be treated successfully with thrombolytic agents, which can be administered in any facility (116). However, patients for whom thrombolytic therapy is contraindicated, or who arrive to hospital after 6 hours of onset of symptoms are likely to require more invasive procedures (PTCA - Percutaneous Transluminal Coronary Angioplasty or CABG -Coronary Artery Bypass Graft), that are available only in tertiary care centres – (59). Furthermore, general clinical guidelines are increasingly advocating the administration of invasive procedures (PTCA being the less invasive of the two revascularization procedures) as soon as the patients arrive to hospital, citing reported findings that the benefits of these procedures exceeds the potential risks, and that the overall outcome may be preferable to clinical paths involving thrombolytic therapy (216).

Data on the time period between the onset of symptoms and arrival to a hospital were not available in Quebec databases for the study period. The variable "distance to the nearest tertiary care centre" was therefore

[10] Two factors may have contributed to having postal codes contained in the study data that did not appear in the Census Canada list. First, postal codes assigned to patients that belonged to PO box addresses would not have corresponding LICO information available. Second, there may have been errors in the transcription of postal codes in the dataset.

created as a proxy measure of the delay between symptom onset and initiation of treatment. This variable was constructed using several sources of information. The 6-digit postal code was obtained for each local community health and social service centre (CLSC) listed in the provincial directory of health care facilities (CLSCs are mandated to provide front line health and social services to residents in their respective communities) (217). Likewise, the six-digit postal code for each tertiary cardiac care hospital in the province was obtained from the same directory. Finally, each admission in the MedÉcho database was assigned a "beneficiary's CLSC code", thereby linking each patient to his or her community CLSC. The road distance was then calculated from the patient's CLSC to the nearest tertiary cardiac care hospital using MapQuest's distance-calculating features (218). Where the road distance was not available through MapQuest, the distance was estimated visually on a provincial map. There were 29,871 records with missing data, either because the postal codes no longer existed, or because the CLSC code had changed. The MSSS website containing historical information on CLSCs was consulted (219) and 29,652 (99.3%) of these missing values were obtained by linking older CLSC codes with newer ones. The remaining 219 distances between the patients' CLSCs and the closest tertiary care centre were imputed using the grand mean value of 175 km (Appendix 11).

Hospital-Level Characteristics

Availability of Revascularization Facilities

The availability of revascularization facilities has been shown to influence hospital mortality rates (138;177;183;189). From the Ministry of Health and Social Services' website (59), 16 hospitals were identified as being equipped with Percutaneous Transluminal Coronary Angioplasty (PTCA) and/or Coronary Bypass Artery Graft (CABG) revascularization facilities

(Appendix 12). Given health policy changes and health system reforms that have occurred in Quebec as in most other jurisdictions in the world (196), facilities may have changed their mandates over time. The list of tertiary care centres was therefore validated against a frequency count of these two cardiac procedures (PTCA and CABG) carried out by each hospital named on the Ministry's list of tertiary cardiac care centres. These data were grouped by hospital and by each of the 7 calendar years in the study period (Appendix 13). Indicator variables were then created to distinguish three types of hospitals, specific to the year during which each admission occurred. The three categories of availability of revascularization facilities were: no revascularization facility, PTCA facilities only, PTCA and CABG facilities (Appendix 14). The availability of revascularization facilities was selected as opposed to the volume of procedures conducted as hospitals are mandated and financed to provide revascularization procedures, but they are not required to perform a minimum annual volume of procedures. Hence the volume of procedures performed at an equipped facility is in part related to the volume of patients requiring these interventions but may also be related to the extent to which hospitals provide care according to guidelines.

Statistical Methods

Various statistical methods have been used to compare hospital performance (220;221). One method frequently used in performance studies involving AMI patients is to compare the ratio of observed to expected mortality at each hospital[11], classifying facilities whose ratios are significantly[12] different from one as outliers (220).

An alternative approach used in profiling studies has been to develop conventional logistic regression models, and to include each hospital as an indicator variable in the model (89). However, this approach is susceptible to unstable estimates originating from hospitals that have small volumes of patients. This instability may result in excess variability in the data, making it impossible to determine whether hospitals are truly outliers using the above criteria. As a result, hospitals with a small number of patients are typically excluded from profiling studies (222), thereby limiting the information available on hospital performance.

Furthermore, the use of indicator variables may lead to difficulties in interpreting the findings. The coefficient obtained for each indicator variable estimates the log odds of death if admitted to a particular hospital as compared with a reference point, such as the log odds of death if admitted to an arbitrarily selected reference hospital, controlling for all other factors included in the model. The selection of the reference

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[11] The expected mortality rate is obtained in the following manner: a logistic regression model is constructed, and includes the strongest predictors of death for the overall population (the study population or an external population). Using this regression model, the probability of death is calculated for each individual patient (also referred to as a risk score). These risk scores are summed within hospitals, to obtain the expected number of deaths for each hospital. A mortality ratio is calculated by dividing the actual (observed) deaths by the expected deaths for each facility. Sometimes, this ratio is multiplied by the overall death rate in the population under study to derive a risk-adjusted mortality rate (RAMR). At this point, outlier hospitals are identified. Hospitals whose RAMR falls above the highest 5% of the distribution, or whose RAMR is significantly different from the overall average, or whose observed mortality rate significantly exceeds its expected mortality rate (mortality ratio significantly > 1.0), are considered to be outliers and are targeted as those needing to improve care.

[12] Throughout this document, the term "significant" implies statistical significance.

hospital has been made in several ways. Some authors have selected the median hospital after having rank ordered all hospitals in the study according to the adjusted probability of death in each hospital (89), arguing that an alternative approach that selects the hospital closest to the mean is susceptible to outlier effects on that mean (223).

Another limitation encountered when using conventional logistic regression models is that each hospital-specific rate estimated with these models is based on the information provided for that specific hospital. Conventional logistic regression models do not make use of all available information, such as is the case for Empirical Bayes estimates that make use of all information obtained from other hospitals in the study population (224;225). This issue is discussed in further detail in the Statistical Methods section entitled: "Estimates of hospital performance", on page 81.

Rationale for the use of hierarchical models

Hierarchical models are well suited to monitor the performance of individual organizations because these are designed to deal with multilevel clustered data (224). These models can be formulated to address questions about how organizations, such as hospitals, affect individuals within them and can, more specifically, be used to monitor the performance of these organizations by ranking establishments according to how their actual performance compares to their expected performance (224). When judging hospital performance levels, it is important to account for patient case mix and ecological variables that are not influenced by the quality of the care provided in hospital. Hierarchical models allow us to examine patient-level outcomes as a function of both patient-level and hospital-level characteristics (226).

Hierarchical Non-Linear (logistic) Regression Models

HLM software (227) was used for the six hierarchical logistic regression analyses conducted for this study. Each analysis was distinguishable by its respective combination of the outcome variable used and the method selected to deal with transfers. Specifically, excluding all transfers, three analyses compared the impact of three different ways to define outcome (in-hospital death, death at 7 days, death at 30 days). Similarly, using death at 30 days as the common outcome, three analyses compared the impact of three different ways to deal with transfers (exclude all transfers, include transfers and assign the outcome to the initial hospital, or include transfers and assign the outcome to the receiving hospital where transfers occurred). Common to all analyses are the covariates included in the hierarchical models and the two-level data structure.

Covariates included in the models

Testing for confounding effects

Testing for confounding involved two components: one tested for the relationship between covariates and the outcome of death, the other component verified whether these covariates differed across hospitals.

Candidate covariates were examined to determine whether they were independently associated with death and whether they varied significantly across hospitals. Based on the results of testing for confounding effect, variables were either included or not included in the final regression models. The statistical program, HLM, was used to test for these confounding effects.

The association between each candidate variable and the outcome of death was examined using hierarchical logistic regression models, with datasets containing each of the six combinations for defining outcomes and for handling transfers. Candidate covariates were considered for retention in the full model if they were significantly related ($P < 0.10$) to hospital mortality in these univariate models. Variables that were not significantly associated with death in the univariate models were again verified in a fully adjusted models (ie: models containing all candidate covariates), to ensure that an apparent lack of association between each candidate covariate and the outcome may not have been due to the effects of another variable (unaccounted for in the univariate model) that attenuated the association between the covariate and the outcome.

The second component to testing for confounding is to demonstrate an association between the covariate and the exposure. In this study, the exposure of interest is the hospital to which a patient is admitted. To test whether each candidate variable differed significantly across hospitals, each candidate variable was included as a dependent variable in a hierarchical model that contained only the hospital identifier. The evaluation of the confounding effect was based on whether or not significant variation was found between the hospital-specific intercepts. These intercepts represent the average value of the covariate for each hospital. The models that were used to test whether covariates differed significantly between hospitals included random intercepts. The statistical methods and interpretation of random intercept models are explained below in further detail under the statistical methods section entitled "partitioning variation" on page 80.

Testing for linearity

Covariates and their coding details are described in Table 3-3. In order to determine whether to include continuous covariates in the hierarchical regression model as continuous or categorical variables, the relationship between each continuous variable and the log odds of death was tested for linearity using the dataset that used in-hospital deaths and that excluded transfers (Figures 3-3 to 3-7). All but one variable were used in their continuous form. The distance to the nearest tertiary cardiac care centre was dichotomized, using 10 km as the dividing point, because of the variable's non-linear relationship with the log odds of death when used in its continuous format.

Two-level data structure

The subscript j is used to denote the hospital (level 2), each patient is admitted to. Within hospital$_j$ (j = 1,2,3,...J), there are i = 1,2,...,n_j patients (level 1).

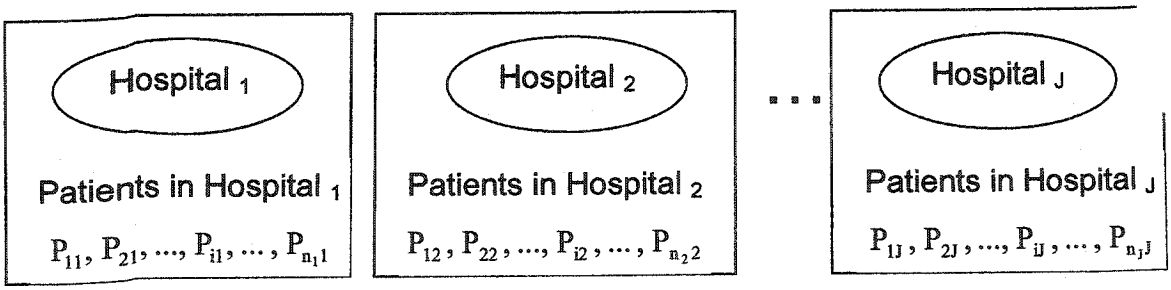


Figure 3-8: Data structure for the two-level hierarchical model

The data are structured as follows:

The 2-level hierarchical models can be arranged to form a level-1 (patient-level) model and a level-2 (hospital-level) model, depicted using the following notation (227):

Level-1 (Patient-level) model

$$Log\left[\frac{\text{Prob } Y_{ij}=1}{\text{Prob } Y_{ij}=0}\right] = \beta_{0j} + \beta_1(agec_{ij}) + \beta_2(femalec_{ij}) + \beta_3(comorrc_{ij}) + \beta_4(licorc_{ij}) + \beta_5(tertd\_bc_{ij})$$

where

Y_{ij}	Represents the outcome for the i^{th} patient in the j^{th} hospital. Y ~ Bernoulli
β_{0j}	Represents the intercept of the patient's hospital (ie: it is the log odds of death in hospital *j* when all patient level predictor values are at the average value in the population).
$\beta_1,\ldots,\beta_5$	Represent the effects of each of the level-1 predictors (age, gender, comorbidity, income (licorc), and distance to nearest tertiary care facility)[13] on the log odds of death

Level-2 (Hospital-level) model

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(ptcafacc) + \gamma_{02}(cabgfacc) + \mu_{0j}$$

where

γ_{00}	Represents the overall log odds of death among all hospitals combined
γ_{01}	Represents the overall effect (slope) of the availability of "PTCA only" facilities on overall log odds of death (as compared with no cardiac facilities)
γ_{02}	Represents the overall effect (slope) of the availability of "CABG and PTCA" facilities on overall log odds of death (as compared with no cardiac facilities)
u_{0j}	This random term represents the variation in intercepts between hospitals and is associated with the j^{th} hospital (ie: it is the deviation of hospital *j* from the overall log odds of death, γ_{00} after adjusting for case mix). $u_{0j} \sim N(0,\tau_{00})$

[13] Note: predictor variables have been centred on their respective grand-mean values in order to allow for a more meaningful interpretation of the intercept value.

Fixed and Random Effects in Hierarchical Models

Hierarchical models consist of both fixed effects and random effects

Fixed Effects

The parameters $\beta_1, \ldots, \beta_5$ represent the slopes for the effect of each of the five patient-level variables, and they have been fixed across all hospitals in this study. In other words, these patient level factors have been modelled to have the same effect on patient mortality, regardless of the hospital to which the patient was admitted.

The overall intercept for all hospitals, γ_{00}, is also a fixed effect in the model. As a result of having centred all predictor variables in the model (see footnote 13 on previous page), the intercept represents the overall log odds of death for a sample patients whose profile is at average values for all predictor variables (226). Without centering, the intercept would represent the overall log odds of death for female patients of age zero, with no comorbidities, living in communities with no households below the LICO cutoff, residing at zero distance from the nearest tertiary care centre, and admitted to a hospital with no revascularization facility. Hence, centering variables on the overall average value in the study population clearly renders the interpretation of the intercept more meaningful in the context of hospital performance studies.

Finally, the level 2 coefficients, γ_{01} and γ_{02}, are fixed effects that represent the average effect of the availability of revascularization facilities on the log odds of death, regardless of which hospital a patient was admitted to.

Random effects

Hierarchical models usually have random intercepts. In this study, these random intercepts represent hospital-specific death rates. Each hospital-specific intercept can be interpreted as the log odds of death for a group of patients admitted to that hospital, where the mix of characteristics or covariates among these patients is the same as that of the overall population. The random effect, u_{0j}, represents the deviation of hospital specific intercepts around the overall intercept, γ_{00}.

Hierarchical models can also include random slope effects (where patient level effects would vary across hospitals, indicating that some hospitals may be better at treating patients with certain characteristics). Such a model would segregate hospitals according to their level of performance with patients having certain characteristics. In other words, had interaction terms been included in the hierarchical models (ie: had the slopes not been fixed across all hospitals), the hospitals would have been segregated into groups defined according to values of the covariate included in the interaction term. For example, a slope allowed to vary by age across hospitals would have resulted in the segregation of hospitals into groups that treat older (or younger) patients better (or worse) compared with other hospitals. In the context of hospital evaluation studies, this type of segregation may be counter-intuitive to the notion of performance measurement. It may be more appropriate to evaluate the outcome of care in a specific hospital for all patients admitted to that hospital, rather than for a select group of patients who may be treated better or worse in that particular hospital. Thus, random slopes were not included in the models. Nevertheless, as some people may argue that certain hospitals treat older patients more aggressively than other hospitals, the interactive effect of age by hospital was tested using a

random slope model for the dataset that excluded transfers and that used in-hospital deaths as the outcome.

Partitioning variation

Implicit in the above description of random effects is an important feature of the hierarchical models used in this study: the total variation observed in patient mortality has been partitioned into "between patients within the same hospital" and "between-hospital" components.

The variation between patients within the same hospital is not explicitly stated in a separate term in the logit model, since the error contained in a Bernoulli distribution is implicit. In other words, no matter what the estimated probability of death is for patients within the same hospital, it must be between 0 and 1. If the estimated probability of death was 0.2, then the estimated log odds of death would be log (0.25) and the true probability of death would be somewhere between 0 and 1.

The variation between hospitals is represented by the term u_{0j}, and is the random variation of the hospital-specific intercepts around the overall intercept, γ_{00} (log odds of death for all hospitals). In hierarchical models, u_{0j} is modelled to have a normal distribution, with mean 0 and variance τ_{00} (Figure 3-9). Using a quantile-quantile plot (q-q plot), the assumption of normality among the hospital-specific log odds of death was tested. A q-q plot provides a graph that illustrates whether or not two datasets come from populations with similar distributions (228). Quantiles of one dataset are plotted against the quantiles of the second dataset, where a quantile is defined as the percent of all data points in the dataset that fall below a given value. For example, the 0.2 quantile is the point at which 20% of the data fall below and 80% fall above that value. A 45-degree reference line may also be included on the q-q plot. If the two datasets follow the same

distribution, the plotted quantile points should follow this reference line. When testing for normality, one of these datasets is replaced with quantiles of a theoretical normal distribution. This type of q-q plot is referred to as a normal probability plot (229). A q-q plot was generated to test whether the hospital-specific log odds of death were normally distributed. These plots are presented in the results section on page 110.

Estimates of hospital performance

The random intercepts model described above is well suited for hospital performance studies. The deviation, u_{0j}, of hospital-specific intercepts provides an indicator of the spread between the best and worst performing hospitals around the overall log odds of death for all hospitals, γ_{00}. Hospital-specific death rates that deviate farther from the overall death rate, γ_{00}, than what can be expected by chance alone are indicative of a better than or worse than expected performance.

Conclusions that are based on these findings and disseminated by the media can have important implications for the reputation of hospitals and can influence the public's confidence in the care offered in certain facilities. It is therefore important that conclusions regarding performance levels be based on accurate estimates. Accepting the highest or lowest ordinary regression estimates as outliers, with no attention paid to the hospital's sample size, would be a naive approach to use when judging hospital performance. Hospitals with small samples can yield unstable estimates for u_{0j} and may appear to be performing at an extreme level, due largely to chance. HLM software provides an Empirical Bayes shrinkage estimator that shrinks the ordinary regression estimate to an extent that is proportional to its unreliability. Hence, a more "believable" estimate (for a hospital with a very large sample size and / or with a measured death rate that is close to the overall population mean) will incur

less shrinkage, whereas more extreme and / or less reliable measures will be pulled towards the mean (224). It should be noted that the extent of this shrinkage is also influenced by the degree of measurement error involved when estimating the variable of interest. As hospital-specific mortality rates are susceptible to measurement error, HLM will provide a shrinkage estimator. This shrinkage estimator is based on the combined influence of two sources of information that can be used to estimate a hospital's true death rate: the measured rate of death in the hospital and the overall population mean death rate, each with its own degree of noise or variation (225). The best estimate for the death rate of each hospital assigns more weight to the source of information that has the least variance (ie: the more stable source of information of the two). It is the relative weight assigned to each of these two sources of information that will determine the degree to which the hospital-specific estimate will be pulled, or "shrunk", towards the overall mean death rate for all hospitals.

Irwig et al. (225) provide an illustration of this combined influence of two similar sources of information using the example of cholesterol level measurements in patients. Noting that cholesterol level measurements are susceptible to measurement error, the authors contrast three different scenarios to illustrate the concept of shrinkage estimators. The first is of a young woman selected from a population in which there is a mean cholesterol level of 5.2 mmol/L. A single screening cholesterol measurement of 9.0 mmol/L for this woman is considered questionable, given what is known of the population value, given that cholesterol level measurements are subject to considerable measurement error, and given that there is only one single reading available for this patient's cholesterol level. The influence of these three factors would result in an estimated level of 8.3 mmol/L, because of shrinkage towards the group mean. Considerable shrinkage towards the mean has occurred because more weight was given to the overall population value; a more stable estimate

than the single measurement value that is substantially higher. In other words, in a situation where an estimate was subject to considerable measurement error, one of two available estimates were considered: one estimate based on the average of an entire population, and another estimate based on a single reading for an individual with no prior history of high cholesterol. In this case, more weight was given to the former, more stable estimate based on the average of an entire population.

The second illustration is of an older woman selected from a population with a higher mean cholesterol level of 6.4 mmol/L. A single screening measurement of the same value of 9.0 mmol/L would have an estimated true level of 8.6 mmol/L, which is greater than the estimated value of the younger woman. Although more weight is given to the population mean than to the single measurement, for the same reasons outlined above, there is less shrinkage that occurs because this older patient was selected from a population with a higher cholesterol level.

The third illustration compares the degree of shrinkage that occurs when one versus several patient cholesterol measurements are taken. A male patient, selected from a population with a group mean cholesterol level of 5.8 mmol/L, has a single screening measurement of 9.0 mmol/L. His shrinkage estimator would be 8.4 mmol/L. On the other hand, had three screening measurements been obtained, with an average reading of 9.0 mmol/l, the estimated value would have been 8.8 mmol/L. In other words, more weight would be assigned to three readings than was assigned to a single reading. Shrinkage will nevertheless occur towards the population value, since this value is more stable than 3 readings, but it will occur to a lesser degree because three readings are now more "believable" than a single one.

The authors present the illustration above as a way to explain why physicians are more likely to repeat extreme laboratory test results for patients who have no history of high cholesterol, knowing that cholesterol level measurements are subject to considerable error. Given a high single reading of 9.0, a physician is likely to repeat the laboratory test, with the expectation that the next reading will be closer to the population mean (in this case a lower value).

Hence, the further the estimated hospital-specific death rate is from the overall mean, the greater the shrinkage to the mean. Similarly, the less stable the hospital's estimated death rate is (due to small sample size), the greater the shrinkage to the mean. As illustrated in Figure 3-10, Empirical Bayes shrinkage estimators (lowest point) for this study are considerably less extreme than ordinary regression estimates (middle point), and the degree of shrinkage is greater where hospital death rates are more extreme and / or where hospitals are smaller (hospital size is represented as $\gamma/\sqrt{n}$, therefore the longer the tail at the top of the graph, the smaller the hospital). The graph illustrates substantial shrinkage in the Bayes estimates for smaller hospitals with extreme ordinary regression estimates. There is less shrinkage that occurs for small hospitals with less extreme ordinary regression values. Shrinkage is almost negligible for large hospitals with death rates close to the overall average.

Converting "log odds of death" to "death rates", a more meaningful measure of hospital performance

As seen above, the intercept β_{0j} estimates the hospital-specific odds of death, in the logit scale, and consists of an estimate of the overall log-odds of death for all hospitals (γ_{00}), and hospital-specific deviations from that estimate (u_{0j}, which is modelled to have a normal distribution, with mean 0 and variance τ_{00}). In other words, $\beta_{0j} = \gamma_{00} + \mu_{0j}$.

To make these estimates more meaningful in the context of hospital performance studies, values provided by HLM in the logit scale were transformed to death rates using the following equation:

$$Death\ Rate_j = \frac{e^{\beta_{0j}}}{1+e^{\beta_{0j}}}.$$

Likewise, the variation around the overall log-odds of death for all hospitals (γ_{00}) was also converted to the death rate scale in order to facilitate the interpretation of findings. The measure of between-hospital variability (τ_{00}, which was obtained from HLM) was used to calculate the range of the log odds of death for most hospitals (95% of hospital specific intercepts distributed normally around the overall intercept, (γ_{00})):

$$SD_{between\ hospital\ variation} = \sqrt{\tau_{00}}$$

and 95% range of hospital specific log odds of death was calculated as:

$$95\%\ range_{log\ odds\ death} = \gamma_{00} \pm 1.96\sqrt{\tau_{00}}$$

This range of values was subsequently transformed to the death rate scale using the following equations:

$$UCL_{death\ rate} = \frac{e^{UCL_{logit(p)}}}{1+e^{UCL_{logit(p)}}}$$

$$LCL_{death\ rate} = \frac{e^{LCL_{logit(p)}}}{1+e^{LCL_{logit(p)}}}$$

Although the variation between hospitals was modeled to follow a normal distribution in the logit scale (Figure 3-11), transforming the log odds of death into death rates results in a skewed distribution for the latter (Figure 3-12).

Tables and Figures pertaining to Chapter 3

Table 3-1: Type of AMI Index Admissions, Quebec Acute Hospitals 1992-1999

Type of Admission (n, %)

Type of admission	n	(%)
Urgent	92,616	98.72%
Semi-urgent*	640	0.68%
Elective*	552	0.59%
Obstetric*	6	0.01%
	93,814	100.00%

* 1,198 admissions excluded where type of admission is not urgent

Urgent Admission cannot be postponed without placing the patient's life at risk or seriously aggravating the illness

Semi-urgent Admission cannot be delayed for a period of time exceeding that specified by the admitting physician, without placing the patient's life at risk or seriously aggravating the illness

Elective A delay in admission will not place the patient's life at risk or seriously aggravate the illness

Obstetric Patient presents to hospital to give birth or gives birth during admission

Table 3-2: Missing Low SES (neighbourhood)* Values

Dataset	Total admissions	Records with missing Low SES* data n, (%)	
Datasets that exclude transfers	78,113	490	0.63%
Datasets that include transfers	91,633	567	0.62%

* "Neighbourhood low SES" is measured in this study using the variable defined as the proportion of the population residing in the patient's FSA (Forward Sortation Area- geographically defined by the 1st 3 letters of the postal code) whose household income is below the Low Income Cut Off (LICO)

Table 3-3: Variable definitions and coding used in hierarchical models

Covariate	Covariate name as used in HLM models	Definition / Description of scale used to measure the covariate
Age	agec	Patient's age in years (continuous variable)
Sex	femalec	1 if patient is female 0 if patient is male
Comorbidity score	comorrc	Ordinal scale. Values range from 1 to 15
Low SES (neighbourhood)	licorc	Proportion of the population residing in the patient's FSA (Forward Sortation Area-geographically defined by the 1st 3 letters of the postal code) whose household income is below the Low Income Cut Off (LICO). (Continuous)
Distance to nearest tertiary care facility	tertd_bc	Distance between the patient's CLSC (Community Health Centres in Quebec) and the nearest tertiary cardiac care facility. (Continuous variable)
Teaching Status	teachc	1 if hospital admitted to is a teaching hospital or is affiliated to a university 0 otherwise
Availability of PTCA facility only	ptca_facc	1 if hospital admitted to is equipped to perform Percutaneous Transluminal Coronary Angioplasty (PTCA) 0 otherwise
Availability of PTCA and CABG facility	cabg_facc	1 if hospital admitted to is equipped to perform Coronary Artery Bypass Grafts (CABG) 0 otherwise

Table 3-3 (Continued)

Outcome Variable	Variable name as used in HLM models	Definition / Description of scale used to measure the covariate
In-hospital death, transfers excluded	d0_notrf	Excluding all transfers from the study population, outcome assigned is: 1 if patient dies in hospital during index AMI admission 0 otherwise
Death within 7 days of index admission, transfers excluded	d7_notrf	Excluding all transfers from the study population, outcome assigned is: 1 if patient dies within 7 days of index AMI admission 0 otherwise
Death within 30 days of index admission, transfers excluded	d30_notrf	Excluding all transfers from the study population, outcome assigned is: 1 if patient dies within 30 days of index AMI admission 0 otherwise
Death within 30 days of index admission, transfers included	d30_wtrf	Including all transfers in the study population, outcome assigned is: 1 if patient dies within 30 days of index AMI admission 0 otherwise

Figure 3-1: Study Population

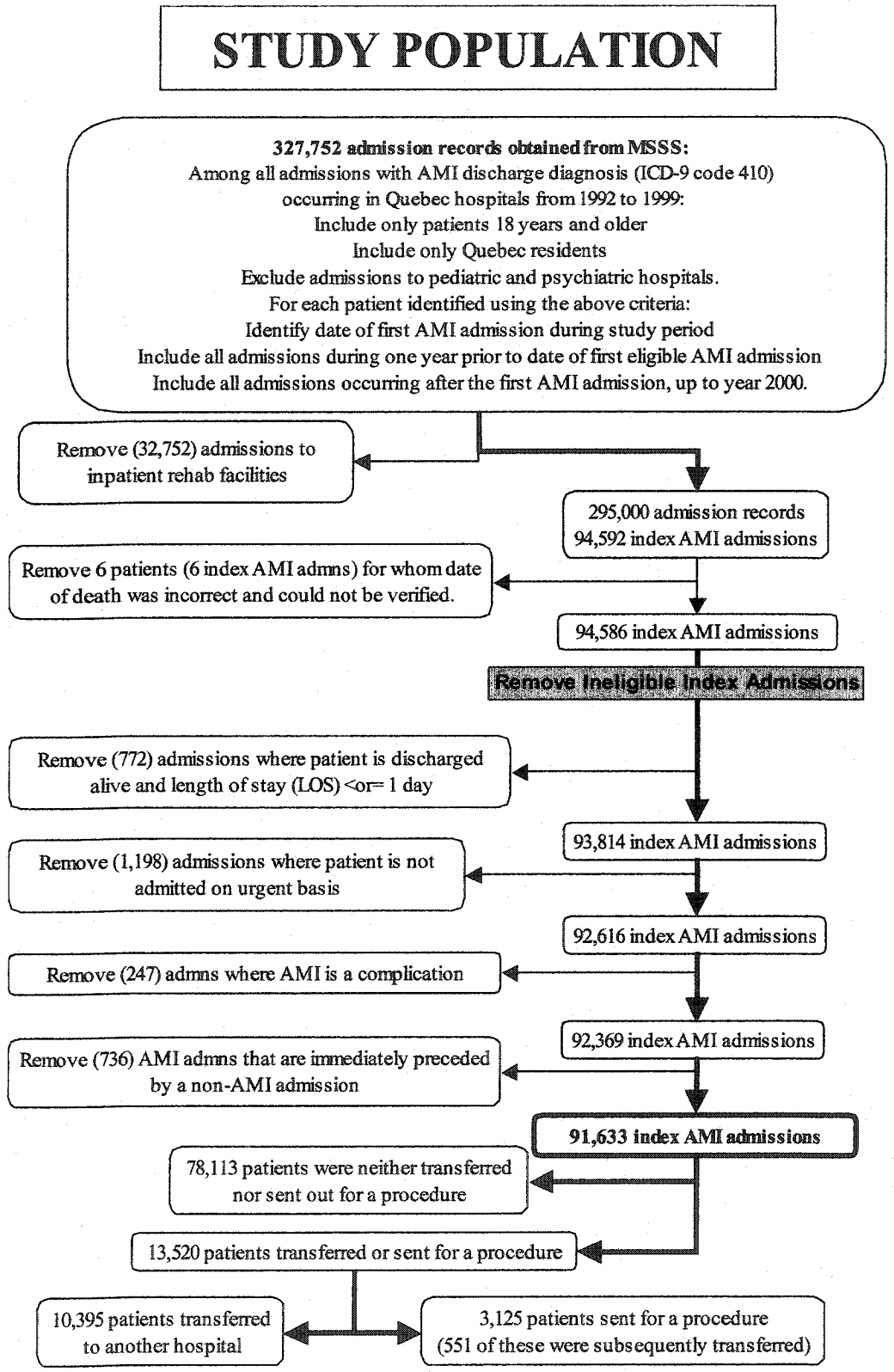
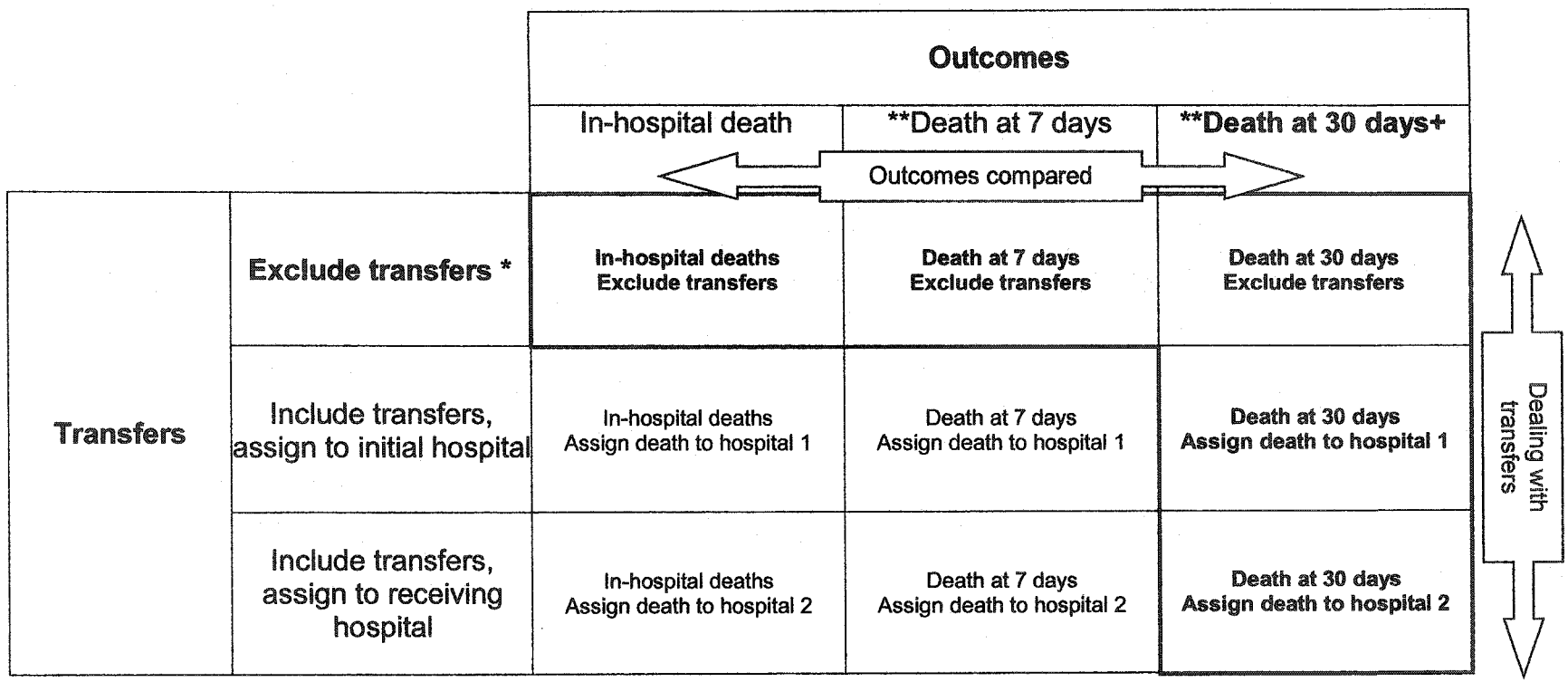


Figure 3-2: Possible ways to define outcomes and to deal with transfers when comparing hospital mortality rates



* Transfers were excluded when comparing hospital performance ranks using 3 ways to define outcomes

+ Death at 30 days post AMI admission was used when comparing hospital performance ranks using 3 ways to deal with transfers

** these values are based on information obtained from death certificates

Figure 3-3: Linearity Test – Death Rate v.s. age

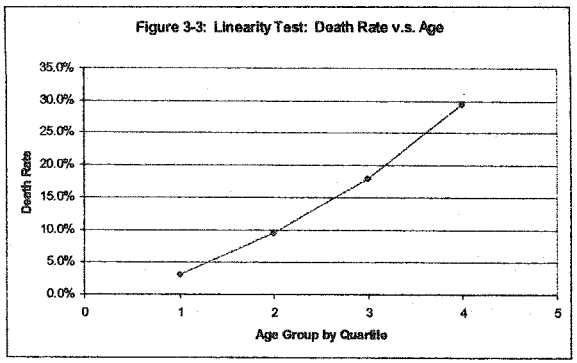


Figure 3-4: Linearity Test – Death v.s. Comorbidity Index Score

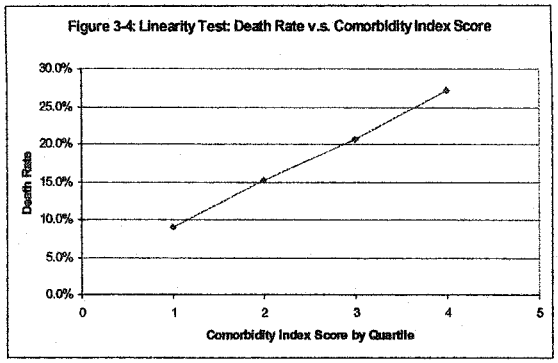


Figure 3-5: Linearity Test – Death v.s. SES (neighbourhood)

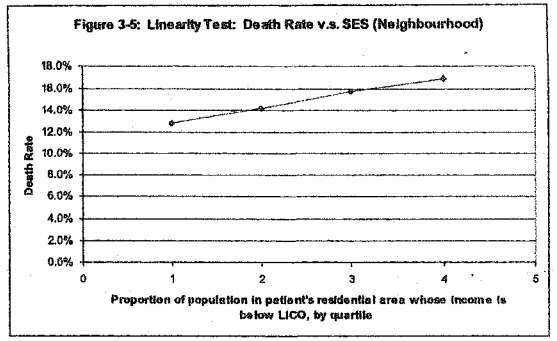


Figure 3-6: Linearity Test – Death v.s. Distance to Tertiary Care Centre

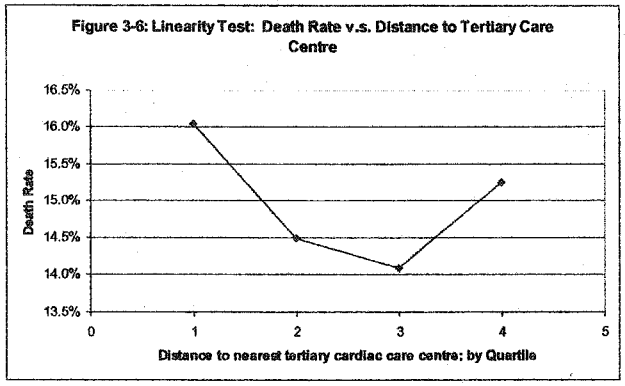


Figure 3-7: Linearity Test – Death v.s. Distance to Tertiary Care Centre (dichotomized)

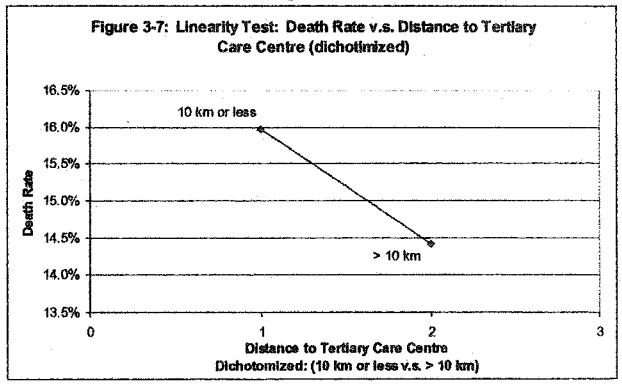


Figure 3-9: Distribution of hospital-specific intercepts around overall intercept

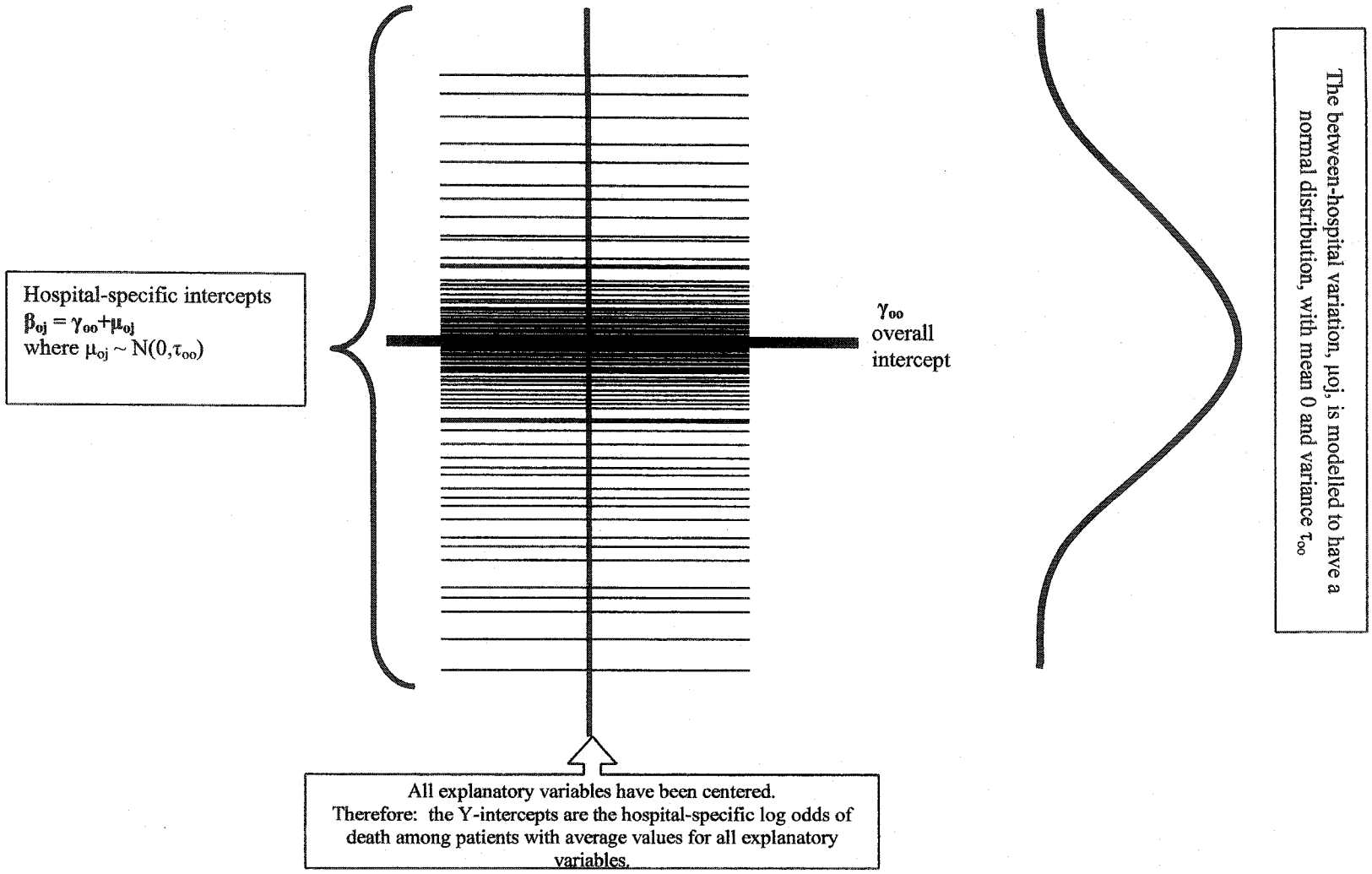
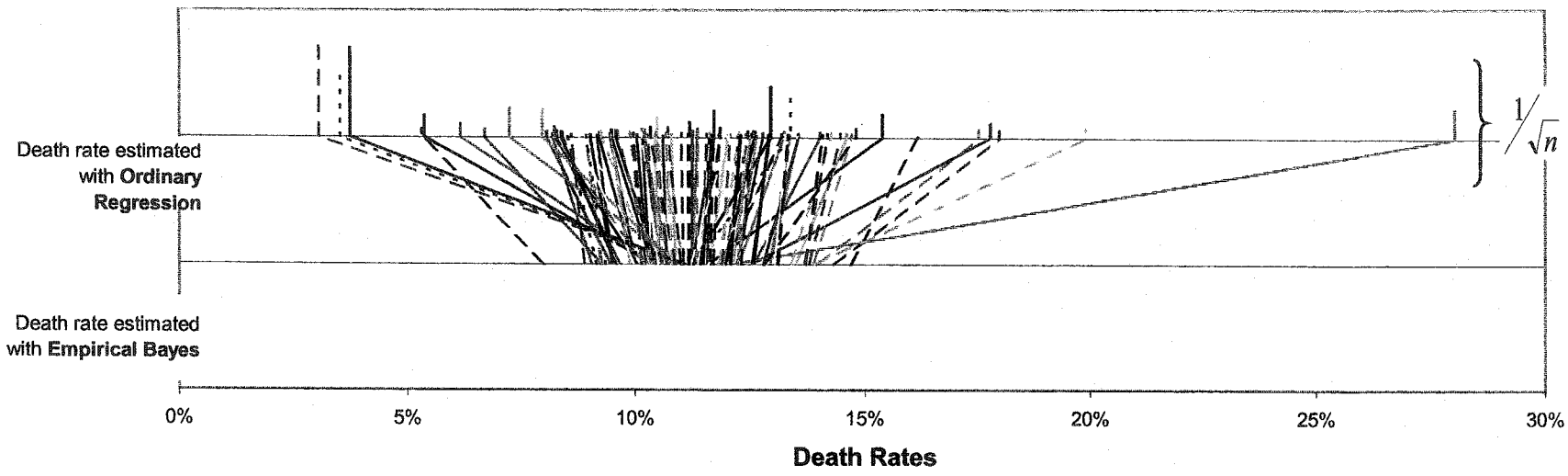
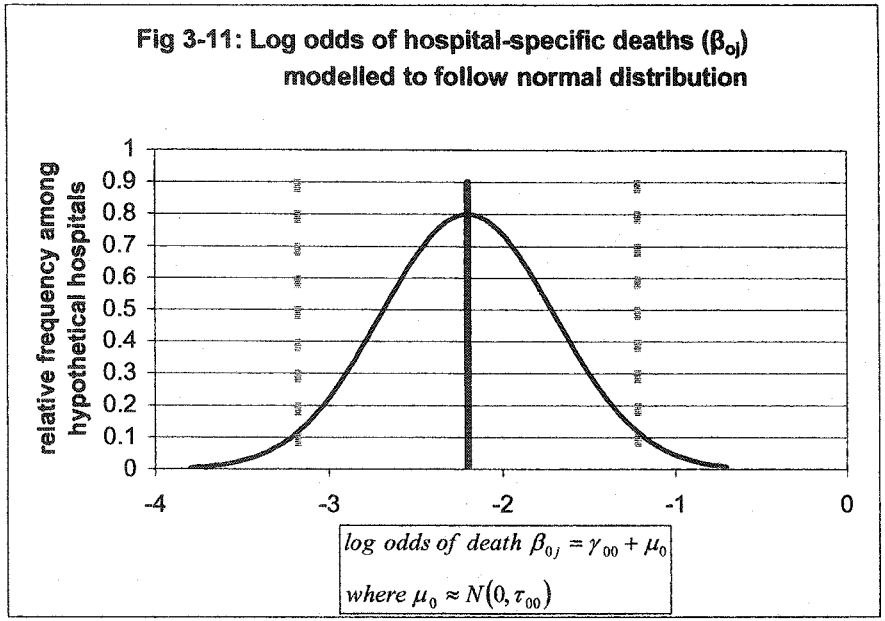


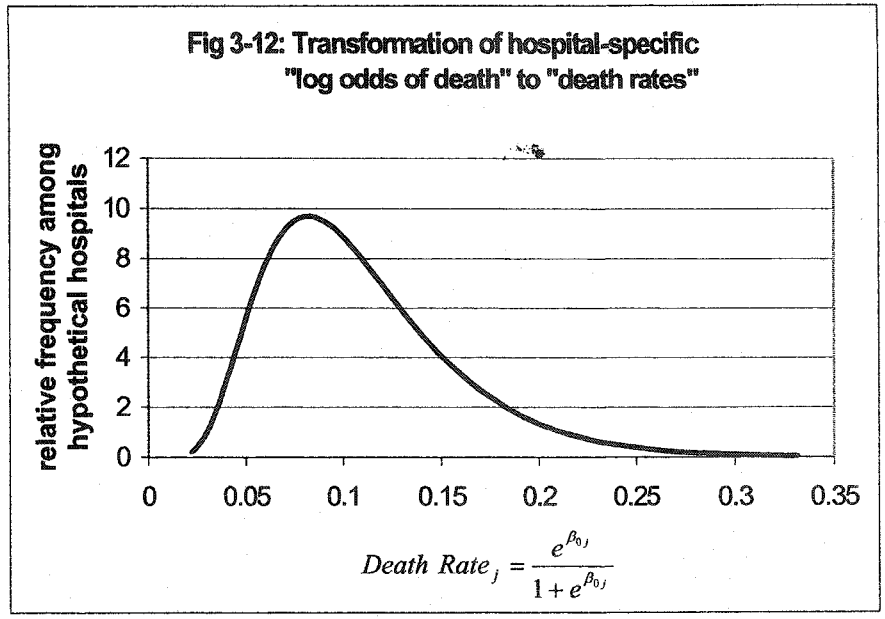
Fig 3-10: Shrinkage in death rates (Ordinary Logistic Regression vs Empirical Bayes)



BAIEHAHA, BASSECOT, CHANNNAL, CHASBEST, CHBAICHA, CHBEAUCE, CHBUCKIN, CHCHANDL, CHCHARLV
CHCHAUVE, CHCOMTOI, CHDAMQUI, CHDOLBEA, CHFLEURY, CHGATINE, CHGRANBY, CHHDAMOS, CHIBOUGA
CHJONQUI, CHLACHIN, CHLACMEG, CHLAFLME, CHLARCHI, CHLASALE, CHLASARE, CHLAUREN, CHLEGARD
CHMANIWA, CHMATANE, CHPIEBOU, CHREDELA, CHREOUTA, CHRESEPI, CHRGAMIA, CHRGGRPO, CHRGMAUR
CHRGRIMO, CHROUNOR, CHSTEMAR, CHSTEUST, CHSTGEBE, CHSTJOTR, CHSTJOTU, CHSTLAUR, CHSTMICH
CHUNILAV, CHUNSHER, CHVALDOR, CHVALLEY, CHVERDUN, CITESANT, CLAUHAUV, CONSEILC, CSINUULI
CSTEMISC, CTRSAFAM, HARGENTE, HAUTCOTE, HAUTSBOI, HBARMEMO, HBELLLEC, HBRMISPE, HCHALEMO
HCHICOUT, HCHRIROI, HCLOUTIE, HCOMPONT, HDALMA, HDARTHAB, HDEMONTS, HDGASPE, HDLEVIS
HDMONTMA, HDMTL, HDQUEBEC, HDROBERV, HDSHERBR, HDSOREL, HDSTJERO, HDUCHRRO, HENFJESU
HGENLACH, HGENLAKE, HHAUTRIC, HJEANTAL, HLAVAL, HMAISROS, HNDEFAT, HNDLAC, HNDSTECX
HPROVMAG, HRELIZMT, HSACCOMT, HSANTACA, HSTECROI, HSTFRAAS, HSTJOA, HSTJOMAL, HSTLUC
HSTSACRE, HSVPSHER, INSTCARM, INUNGESH, JGH, LEBEL, MGH, NOTRDAME, PAVLEROY
PORTCART, REDMEMOR, RESARIYA, RVH, STJEANEU, STMARYS, THORACIQ, TULATTAV

Figure 3-11: Log odds of hospital-specific deaths (βoj) modelled to follow normal distribution





Chapter 4 RESULTS

Descriptive Statistics

Overall, mortality rates within 30 days post-AMI index admissions (transfers included) have decreased slightly by 1% (from 13% to 12%) between 1992 and 1999 in Quebec (Table 4-1). The overall average hospital length of stay has also declined from 11.9 days to 9.3 days for AMI index admissions in Quebec, between 1992 and 1999 (Table 4-2). Similarly, the average length of stay for episodes of care, consisting of one or more consecutive admissions, has decreased from 13.7 days to 11.1 days during the same period of time. Figure 4-1 shows that the average length of stay for AMI patients varies among hospitals, ranging from 6.6 days to 23.6 days.

Table 4-3 presents the characteristics of patients admitted with an index AMI to acute care hospitals in Quebec (1992-1999). The data are grouped under four types of hospitals that patients were admitted to, distinguished according to the volume of AMI index admissions and according to the availability of revascularization facilities:

1. Hospitals without revascularization facilities, with <400 index AMI admissions during the study period (corresponding to an average yearly volume of fewer than 50 index AMI admissions);
2. Hospitals without revascularization facilities, with 400 to 999 index AMI admissions (average yearly volume of 50 to fewer than 125);
3. Hospitals without revascularization facilities, with 1000 or more index AMI admissions (average yearly volume of 125 or more);
4. Hospitals with revascularization facilities (regardless of volume of index AMI admissions).

Most index admissions occurred in hospitals treating an average of 125 or more new AMI patients per year, which are not equipped with revascularization facilities. There were no substantial differences in patient age, gender and comorbidity across the four types of hospitals. The average age of patients admitted for an index AMI admission during the study period was 66 years old, with 35% of all patients being women. Almost half (45%) of the patients admitted had a comorbidity score of 0, 28% had one comorbidity, 14% had a score of 2, and 13% had a score of 3 or higher on the comorbidity index.

Patients treated in hospitals equipped with revascularization facilities tended to live in areas with higher prevalence of low SES than did patients admitted to other types of hospitals (30% low SES[14] compared to between 22% and 24% low SES). Patients admitted to larger hospitals or hospitals equipped with cardiovascular facilities tended to live closer to these (an group average distance of 18 km and 46 km respectively) than did patients admitted to small and medium volume hospitals (274 km and 116 km respectively).

The proportion of AMI patients who were transferred to another hospital during their index admission nearly doubled from 10% in 1992 to more than 19% in 1999, Figure 4-2.

Table 4-4 presents patient and hospital level characteristics according to patient transfer status. Of the 91,633 patients included in this study, 13,520 (15%) were transferred to another acute care hospital during their index admission. Patients who were transferred were more likely younger (60 vs 67 years old), male (72% vs 64%), and had fewer comorbidities

[14] LOW SES variable represents the proportion of the population in the patient's FSA (Forward Sortation Area: defined by the 1st 3 digits of the postal code) whose household income is below the LICO (Low income cut off). For example, a Low SES value of 25% indicates that 25% of the people residing in the patient's FSA have a household income that falls below the LICO (Low income cut off).

(55% vs 43% had a comorbidity score of 0) than patients who were not transferred. Transferred patients lived in areas that were slightly less poor than patients who were not transferred (22% vs 25% of residents in neighbourhood with household income lower than LICO). Transferred patients also lived slightly farther from cardiac tertiary care centres than did non-transferred patients (94 km vs 72 km).

Transferred patients were less likely to die (4%) within 30 days of their index admission than were non-transferred patients (15%).

Lastly, 18% of the patients admitted to hospitals without revascularization facilities were transferred to another hospital, regardless of the hospital's volume of new AMI patients admitted during the study period. Only 1% of new AMI patients admitted to a tertiary cardiac care centre were subsequently transferred to another facility.

Table 4-5 presents profiles of the 116 hospitals included in this study. These figures represent the range of and average values of hospital profiles, where each hospital profile is based on the mix of patients admitted. The table reports these values according to the four types of hospitals, defined in terms of the volume of new AMI patients admitted and in terms of the availability of revascularization facilities.

Hospital profiles according to patient mix by age, by gender or by comorbidities did not vary according to the type of hospital. It should be noted that hospital profiles are more varied among smaller hospitals than among medium or larger hospitals. For example, the average proportion of patients who were female among hospitals with less than 400 admissions ranged from 25% to 50% whereas the average proportion of patients who were female among hospitals admitting more than 1000 new AMI patients ranged from 32% to 40%. This difference in range is likely

due to the fact that hospital profiles are more variable among smaller hospitals (where sample size is smaller) than among larger hospitals.

Hospitals with revascularization facilities admitted patients residing in neighbourhoods where there was, on average, 30% of the population whose household income fell below the Low income cut off, representing a mix of poorer patients among these hospitals compared with other hospitals. Interestingly, the range of profiles is similar between smaller hospitals (15% to 33%) and larger hospitals (18% to 35%).

The average distance to a tertiary care centre among patients admitted to a hospital was shortest among hospitals with revascularization facilities (18 km compared with 51 km, 120 km, or 406 km for large, medium and low volume hospitals respectively). However, the range of these average distances among hospitals is substantially larger for small hospitals (14km to 687km) than for large hospitals (8km to 122km) or for hospitals equipped with revascularization facilities (9km to 36km). These results indicate a more varied mix of urban-rural settings for smaller hospitals, whereas larger hospitals, or those equipped with revascularization facilities, tend to be located closer to or in larger urban or suburban areas.

The hospital-specific crude death rates did not vary according to the four types of hospital, although the range of these rates is slightly wider among smaller hospitals (4.2% to 21.1%) than among larger hospitals (10.1% to 17.9%).

Results of testing for confounding effects

Candidate covariates were tested to determine whether they were:

1. independently associated with death and
2. whether they varied significantly across hospitals.

Candidate covariates that were tested in univariate analyses for their association with death were considered for retention in the full models if they were significantly related ($P < 0.10$) to hospital mortality in these univariate analyses. Table 4-6 presents the results of the univariate analyses performed for each of six datasets that included 3 different ways for defining outcomes and for each of the 3 different ways for handling transfers. Patient characteristics (age, gender, comorbidity, low SES and distance to nearest tertiary care centre) were significantly related to death in all univariate analyses. Among hospital characteristics, teaching status was not associated to the outcome of death in any of the datasets. Availability of CABG and PTCA facilities was associated to death in all but one dataset (the one that defined outcome as death at 30 days post-AMI admission and that included transfers, assigning the outcome to the first hospital). To allow for comparisons to be made across analyses, all models had to contain the same variables. Therefore, as the variable "availability of CABG and PTCA facilities" was independently related to death in all but one of the univariate analyses, it was retained as one of the variables to include in all 6 analyses.

Availability of PTCA only facilities was not significantly associated with death, although it should be noted that the standard error (SE) was large, given the small number of hospitals in this category. It was nevertheless included in the models as it was an indicator variable created to be used in conjunction with "CABG and PTCA facilities". Lastly, teaching status was not related to death in any of the univariate analyses conducted. A conservative approach was taken to verify whether teaching status might

be related to death after having accounted for all other candidate covariates. Teaching status was not associated to death in any of the six analyses and was therefore not included in the final models. A summary of the above findings, identifying variables that were independently associated with death in the univariate analyses, is provided Table 4-7.

The next step in determining the confounding effects of each candidate covariate was to examine the relationship between each of these variables with the specific hospital a patient was admitted to. Figures 4-3 to 4-10 illustrate the distribution of the values of each covariate across hospitals.

The mean age of patients in each hospital varied substantially across hospitals (Figure 4-3), with the average age of patients for the 116 hospitals ranging between 60 and 74 years. Of particular interest are hospitals with an average age of patients situated at the extreme ends of this range. Four hospitals had an average patient age above 73 years, 3 of which admitted less than 100 patients during the study period. The fourth hospital, "STMARYS", admitted more than 900 patients during the study period, which represents an average of 110 patients per year and suggests that extreme values of average patient age by hospital may not be due only to the small sample sizes of hospitals. At the other end of the spectrum, the average age among patients admitted to 5 of the 116 hospitals was between 60 and 63 years of age. Two of these hospitals, admitted more than 125 patients per year (1000 patients during the entire study period).

The range of the average proportion of female AMI patients admitted to each hospital ranged from 28% to 48% (Figure 4-4). Females represented 45% or more of all patients admitted to 3 of the 116 hospitals included in thus study. Two of these hospitals, "STMARYS" and "HSTSACRE", admitted more than 800 patients during the study period,

which represents an average of more than 100 patients per year for each hospital. Less than 30% of patients admitted to 3 specific hospitals were female, two of which were large hospitals ("INSTCARM", and "HLAVAL") that admitted more than 2000 patients during the study period (corresponding to more than 250 AMI patients per year in each hospital).

Similar results were obtained when comparing the average co-morbidity score among patients admitted to a hospital (Figure 4-5). Scores ranged from 0.50 to 1.72, with large hospitals situated at each extreme. "CHVERDUN" admitted more than 1500 patients during the study period, where patients had an average co-morbidity score of more than 1.65. "HGLENLAKE" admitted more than 1200 patients during the study period, with average co-morbidity score of less than 0.65. To address concerns that may be raised by some people who may argue that differences in co-morbidity among patients admitted to different hospitals may be due to age differences, the average co-morbidity score among patients admitted to each hospital was also examined after accounting for the age of patients. Figure 4-6 illustrates that, after accounting for age, there still remains considerable variation among the average co-morbidity scores for patients admitted to specific hospitals. Scores ranged from 0.45 to 1.64, with large hospitals again situated at each extreme. For each hospital, the average number of co-morbidities coded patients' records was also compared with the volume of AMI index admissions in that hospital. Figure 4-7 illustrates these results, with hospitals ordered according to the number of index AMI admissions during the study period. These results show that the average number of co-morbidities coded for each AMI patient does not depend upon the volume of AMI patients, which can be considered an indication of the relative size of, and resources available in each hospital.

There was variation among hospitals in the average prevalence of low SES in the areas of residence of AMI patients (Figure 4-8), ranging from 13% to 43%. Among the hospitals with the highest values are "HJEANTAL", "HSTLUC", and "NOTRDAME" with more than 900, 700 and 1300 admissions respectively, during the study period. Three hospitals with low prevalence values for low SES each admitted less than 200 patients during the study period "CHLARCHI", "BASSECOT", and "STJEANEU".

There is substantial variation among hospitals in the average distance between patients' and the nearest tertiary cardiac care centre (Figure 4-9), even after removing four hospitals that are outliers ("TULATTAV", "CSINUULI", "BASSECOT", "CONSEILC") (Figure 4-10). The average distance to the nearest tertiary care hospital for patients admitted to a hospital varies from 5km ("JGH") to 690 km ("CHCHANDL"). Most hospitals with high volumes of AMI patients admit patients who live closer to tertiary care centres, which is understandable since tertiary care centres are usually located in urban centres that have a higher concentration of residents than rural areas.

In summary, each of the candidate covariates varied across hospitals. The distribution of these patient and hospitals characteristics differed significantly according to which hospital the patients were admitted to (Table 4-8).

Covariates that met both conditions presented above for confounding variables were included in the full model, using each of the six datasets (defined according to the outcome used and the method used to deal with transfers). Analyses were performed for each of these six datasets in order to determine whether the effect of each variable remained significant when included in the full models. Variables that were significant in at least

one fully adjusted analysis were retained in the final model (Table 4-9). The models used for each of the six analyses are shown in Appendix 15.

Interaction between age and hospital patient is admitted to

The interaction between patient age and the hospital the patient is admitted to was tested in a random slope model, where transfers were excluded and the outcome was defined as in-hospital deaths.

A large amount of variability between slopes would indicate a strong interaction between age and the hospital the patient is admitted to, signalling differences in the effect of age on mortality, according to which hospital the patient is admitted to. Results indicated a significant but very small variability in the hospital-specific slopes for age (variance 0.00005, p-value 0.001). In other words, although the effect of age on death is different between hospitals, this difference is very small. Hence, although some people may argue that there are anecdotal differences in the extent to which older patients are treated aggressively, these differences are not large. Furthermore, as stated in the methods section entitled "Random effects" (pg. 79), allowing the slope for age to vary across hospitals would result in the segregation of hospitals into groups that treat older (or younger) patients better (or worse) compared with other hospitals. As a first step in hospital performance evaluations, it may be more important to identify how hospitals perform overall compared with others, and analyse differences in performance according to specific patient characteristics separately, as a way to identify some factors explaining differences in overall hospital performance levels. Therefore, random slopes were not included in the final models retained for the hierarchical multivariate analyses performed in this study.

Variation in death rates between hospitals: Chance or not?

Before comparing hospital mortality rates in order to identify outliers, it is important to determine whether there is more variation in the observed death rates between hospitals than would be expected by chance alone. In other words, differences in mortality rates between hospitals should be shown to be due to factors that extend beyond what can be explained by patient characteristics and hospital characteristics such as the type of facility. In the context of hospital performance studies, differences in patient outcomes that remain after having taken these factors into account are considered to be due to differences in hospital quality of care (80).

As seen earlier in the Statistical Methods section, "Partitioning Variation", page 80, hierarchical models can be used to partition the total observed variance in the log odds of death into "variation between patients within the same hospital" and "variation between-hospital". The variance component of greatest interest when conducting hospital performance studies is the variation between hospitals in the log odds of death (τ_{00}) (224). Table 4-10 displays the estimated variance in the hospital-specific log odds of death for each of the six analyses. These variances are presented for 3 models:

1. The first model does not take patient or hospital characteristics into account. The six analyses therefore estimate the crude hospital-specific death rates.
2. The second model takes patient characteristics alone into account. These analyses do not take into consideration the availability of revascularization facilities in the hospitals.
3. The third model takes patient and hospital characteristics into account.

Table 4-10 illustrates how the progressive inclusion of patient and hospital characteristics in the analyses reduces the variation between the

hospitals' log odds of death. Taking the last analysis as an example (where transferred patients are included and the outcome at 30-days post-AMI admission is assigned to the receiving hospital), the variance (τ_{00}) in the log odds of death is 0.106 in the crude analysis. When patient characteristics are taken into account, the variance decreases to 0.053, and when patient and hospital characteristics are both taken into account, it is reduced further to 0.030.

The total variation between hospital log odds of death was estimated by (τ_{00}) in the crude analyses, which were the analyses that did not adjust for patient or hospital characteristics. The residual variation between the hospital log odds of death was estimated by (τ_{00}) in the fully adjusted analyses, which were the analyses that adjusted for both patient and hospital characteristics.

The portion of the total variation between hospital-specific log odds of death that is explained by both patient and hospital factors ranges between 50% and 72% for each of the six analyses (Table 4-10). This variation was calculated using the following equation:

$$portion\ of\ total\ variation\ explained = \frac{\tau_{00}(crude) - \tau_{00}(adjusted)}{\tau_{00}(crude)}$$

In other words, patient and hospital characteristics explained a portion of the total variation observed in the log odds of death between hospitals, and this portion is expressed as a proportion of the total variation. What remains, is "otherwise unexplained variation". In the context of hospital performance studies, this otherwise unexplained variation represents differences in the quality of care provided by different hospitals or residual unexplained variation.

Differences between hospitals' log odds of death were reduced considerably after accounting for case mix differences (differences in patients characteristics) and to a lesser degree after accounting for hospital characteristics. It is therefore important to verify whether the remaining differences between the hospitals' log odds of death are significant, before proceeding with performance comparisons. Table 4-10 shows that this residual variation (τ_{00}) remained significant ($p<0.05$) after accounting for patient and hospital characteristics, regardless of which patient outcomes were used or of how transfers were handled.

It is possible that statistical significance was attained primarily due to the large sample size used in this study. It is therefore important to consider whether this variation is clinically important. However, it is difficult to judge the clinical relevance of the differences in hospital outcomes when these are presented in the logit scale (τ_{00} represents the variance of hospital-specific log odds of death around the overall intercept, γ_{00}).

To help interpret these measures, the overall log odds of death and the range of estimated logits of death rates for 95% of all hospitals were transformed into death rates using the following equations:

$$death\ rate = \frac{e^{\gamma_{00}}}{1+e^{\gamma_{00}}}$$

$$UCL_{death\ rate} = \frac{e^{\left(\gamma_{00}+1.96\sqrt{\tau_{00}}\right)}}{1+e^{\left(\gamma_{00}+1.96\sqrt{\tau_{00}}\right)}}$$

$$LCL_{death\ rate} = \frac{e^{\left(\gamma_{00}-1.96\sqrt{\tau_{00}}\right)}}{1+e^{\left(\gamma_{00}-1.96\sqrt{\tau_{00}}\right)}}$$

where γ_{00} is the overall log odds of death and τ_{00} is the variance in the hospital-specific log odds of death.

Figure 3-11, presented earlier, illustrated how hospital-specific intercepts (β_{0j}) are modelled in HLM to follow a normal distribution around the overall intercept (γ_{00}), with mean 0 and variance (τ_{00}). To test this

assumption, a normal probability plot[15] was created using the Empirical Bayes estimates for hospital-specific log odds of death for each of the six analyses in this study. Figure 4-11 illustrates each of these plots. The alignment of the data points along the 45-degree reference line demonstrates the extent to which the hospital-specific log odds of death follow a normal distribution for each of the six analyses (230). The plots show that all distributions follow the 45-degree reference line, confirming that the assumption of normality is reasonable.

When the Empirical Bayes estimates of the hospital-specific log odds of death are transformed to hospital-specific mortality rates, the data points are no longer normally distributed. This slightly skewed distribution is illustrated in Figure 4-12, for the analysis that excluded transfers and used in-hospital deaths as the outcome.

The charts in Figures 4-13 to 4-15 present the ranges of estimated hospital-specific death rates for the six analyses in this study, following the same 3 scenarios presented above (one set of analyses was conducted without adjustment, one set was conducted for models that included patient characteristics, and one set was conducted for models that included both patient and hospital characteristics).

When patient and hospital level characteristics were not taken into account in any of the six analyses conducted in this study, the spread in crude estimated death rates among 95% of the hospitals was from 9.1% to 15.5% (Figure 4-13). For each analysis, the range of death rates is asymmetrical relative to the overall average death rate because of the transformation of the hospital-specific log odds of death to hospital-

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[15] Q-Q plots were defined in the methods section "Partitioning Variation" on page 80. Normal probability plots are a specific type of q-q plot in which quantiles of one dataset are plotted against the quantiles of a theoretical normal distribution. If the hospital-specific log odds of death follow a normal distribution, the points on the q-q plot will follow a 45-degree reference line that is often included in the plots.

specific death rates referred to above. When patient characteristics alone were included in the six analyses (Figure 4-14), the spread between the highest and lowest expected death rates for 95% of the hospitals diminished considerably, ranging from 5.3% to 8.7%. This spread was slightly reduced when hospital characteristics (availability of revascularization facilities) were also included in the analyses, resulting in death rates ranging from 4.4% to 6.9% (Figure 4-15). Nevertheless, the range between the highest and lowest hospital-specific expected death rate, among 95% of all 116 hospitals, is more than 2%, which is considered to be clinically important according to the "1% difference in mortality rates" criterion used by many clinical trials studying the efficacy of cardiovascular drugs for AMI patients[16].

Do hospitals perform differently depending upon the method used to evaluate them?

Six hierarchical analyses were used to compare hospital performance levels. The results obtained from each of these six analyses were used to determine whether hospitals were judged differently depending upon the method used to evaluate their respective performance levels. The mean and range of the estimated hospital-specific mortality rates are presented in Table 4-11 and Table 4-12. When comparing three ways to define outcomes, the spread in adjusted mortality rates ranges from 4.0% to 6.7%. When comparing three ways to handle transfers, the spread in adjusted mortality rates ranges from 5.6% to 6.0%.

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[16] This "1% difference in mortality rate criterion" or benchmark seems to have been adopted by the medical community working in cardiovascular health, whereby a 1% change in mortality is considered to be clinically important. This benchmark seems to have emanated from the largest (41,021 patients) randomized trial in clinical cardiology that compared the effects of 4 thrombolytic strategies on outcome (death, stroke, and combined outcome) (246). The researchers reported a 1% reduction in mortality for the t-PA group, when compared with the streptokinase group. The authors declared this reduction in adverse clinical outcomes to be clinically important, and the 1% reduction in mortality was thereafter adopted by the clinical community as the benchmark sought when determining the clinical relevance of the impact of medical interventions in cardiology.

Figures 4-16 and 4-17 illustrate how hospital-specific death rates can change, both in absolute terms and relative to other hospitals, depending on the methods used to define the outcome (Figure 4-16) and the methods used to handle transfers (Figure 4-17).

When comparing the three different ways to define outcomes, the hospital mortality rates were lower and less widely dispersed among hospitals when using death at 7 days as the outcome. Hospital-specific mortality rates calculated using in-hospital deaths and death at 30 days were similar in range and average value (the overall mean is denoted by the thick central line in the graph), as shown in Figure 4-16. Common to all three analyses, hospital mortality rates seem concentrated within a 2% mortality rate range, with some outlying hospitals. It should also be noted that hospital mortality rates changed relative to others, as illustrated by the crossover of the lines across the three different outcomes used. Figure 4-18 illustrates the crossover in hospital-specific mortality ranks relative to others, comparing only in-hospital deaths with deaths at 30 days. This figure also distinguishes between hospitals that have revascularization facilities (thick lines) from those that do not (thin lines). Having accounted for this hospital characteristic, mortality rates were equally varied for both types of hospitals. Of particular interest was the degree to which nearly all hospitals changed in their ranks relative to others, with substantial changes occurring for some hospitals.

Figure 4-17 depicts hospital-specific mortality rates according to the methods used to handle transfers. This figure also illustrates considerable changes in the hospital ranks relative to others. Figure 4-19 illustrates the hospital mortality rates, differentiating between hospitals with revascularization facilities (thick lines) and those without (thin lines). Although the overall mean and range did not change substantially

between the three ways of handling transfers, mortality rates decreased slightly when transfers were included in the analyses. Among hospitals without revascularization facilities (thin black lines), a substantial decrease in mortality rate between the first and second analyses (excluding transfers compared with assigning the transfer outcome to the initial hospital) indicates that most patients transferred out by that hospital remained alive at 30 days post AMI admission. This pattern suggests that the initial hospital provided appropriate care and judgement regarding timely transfers. Among hospitals with specialized facilities (thick red lines), a substantial decrease in mortality rates between the first and third analyses (excluding transfers compared with assigning transfer outcome to the receiving hospital) indicates that most patients transferred to that hospital were alive at 30 days post AMI admission. This pattern suggests that the receiving hospital provided appropriate rescue care to the patients that were transferred in (alternatively, it may also mean that patients that were transferred to that particular hospital were systematically healthier than patients transferred to other hospitals).

Figures 4-16 and 4-19 illustrate that hospital ranks do change relative to others, depending upon the methods used to define outcomes and to handle transfers. Various approaches can now be used to estimate the degree to which these methods influence how a hospital's level of performance is estimated. This study applies four such approaches to compare results across the six analyses:

1. Rank correlations compared across the six analyses
2. The movement of hospital mortality rates across quintiles
3. The movement of hospital mortality rates in and out of the highest and lowest deciles
4. Rankings, based on hospital-specific adjusted death rates, used to identify significant outliers

Rank correlations compared across six analyses

Table 4-13 and 4-14 indicate there is a strong correlation in hospital ranks, regardless of the method used to define outcomes or the method used to deal with transfers. The strongest correlation between hospital ranks (0.97) occurs when hospital mortality rates (based on death at 30 days post-AMI admission) are compared between a study population that excludes transfers and one that includes transfers, assigning the outcome to the receiving hospital. The lowest correlation (0.86) occurs when comparing ranks obtained using in-hospital deaths with ranks obtained using death at seven days post-AMI admission.

Although there is good overall agreement between the ranks obtained by hospitals using different methods, these findings do not rule out the possibility of important differences in the conclusions drawn regarding a specific hospital's performance based on the methods used to define outcomes or to deal with transfers. Hence, an alternative approach might be to focus on the movement of hospitals across quintiles, to determine whether most hospitals remain within the same grouping or not.

The movement of hospital mortality rates across quintiles

Tables 4-15 and 4-16 illustrate the concordance in quintile classification for pairwise comparison across the six different analyses. Quintile 1 represents the lowest 20% of hospital mortality rates, and consists of hospitals that have better outcomes compared to others. In contrast, quintile 5 represents the highest 20% of hospital mortality rates, consisting of hospitals that have worse outcomes compared to others. Hospital

quintiles were compared using two analyses at a time. A positive change in the number of quintiles means that a hospital had a higher mortality rate using the second of the two methods compared. A negative change in quintile means that a hospital had a higher mortality rate using the first of the two methods compared.

Table 4-15 presents the concordance in quintile classification for pairwise comparisons of outcomes, comparing two methods for defining outcomes at a time. Concordance ranged from 57% to 66%, however, there was discordance in quintile classification of 34% to 43% of the time (shaded cells). The largest change in quintiles among these comparisons was 3, which occurred when comparing hospital mortality rates using in-hospital deaths with rates obtained using death at 7 days (2 hospitals moved up three quintiles) or with rates obtained using death at 30 days (1 hospital moved up 3 quintiles). The maximum improvement in hospital performance ranks across quintiles, when comparing two methods for defining outcomes at a time, was a decrease by 2 quintiles. This magnitude of improvement occurred when comparing in-hospital deaths with deaths at 7-days (6 hospitals) or with death at 30 days (2 hospitals). One hospital improved its rank by moving down 2 quintiles when comparing its mortality rate using death at 7 days with death at 30 days post-AMI admission.

Table 4-16 presents the concordance in quintile classification for pairwise comparisons of 3 ways to handle transfers. Discordance in quintile classification ranged from 23% to 32% (shaded cells). For each of the three comparisons made, 1 hospital rank increased by 2 quintiles. Two hospitals performed better, with ranks moving down 2 quintiles, when transfers were assigned to the second hospital versus the first hospital.

In summary, Tables 4-15 and 4-16 illustrate more discordance in hospital mortality rates quintile classification when comparing three methods for comparing outcomes than when comparing three ways of handling transfers. In-hospital deaths compared with deaths at 7 days or with deaths at 30 days lead to the most changes in quintiles for hospital ranks.

However, in light of the relatively small spread across hospital mortality rates and the normal distribution of the log odds of death, with most hospital-specific values concentrated around the overall average value, the movement of hospital mortality rates in and out of the middle quintiles may be of less relevance to evaluators interested in identifying "problem hospitals" or "exemplary performers". An alternative but somewhat related approach involves focusing on hospitals that rank within the extreme upper and lower ranges of the entire spectrum.

The movement of hospital mortality rates across the highest and lowest deciles

Another way to classify the performance of hospitals is to rank hospitals by deciles (158) and to identify those with adjusted mortality rates that are in the highest and lowest deciles among all hospitals studied. Hence, hospitals with adjusted mortality rates falling within the highest 10% of all rates might be considered to be among the "worst" performers, while those with mortality rates falling within the lowest 10% might be considered to be among the "best" performers.

The degree of consistency with which hospital mortality rates are in the highest or lowest deciles was compared across the three methods for defining outcomes (Table 4-17) and across the three methods for handling

transfers (Table 4-18). For each comparison made (three ways to define outcomes and three ways to handle transfers), the number of times each hospital fell within the highest (or lowest) decile was recorded. These numbers range from zero, where the hospital rate is never in the highest (or lowest) decile, to 3 times, where the hospital rate falls in the highest (or lowest) decile regardless of the method used to define the outcome, or the method used to handle transfers.

When comparing the three analyses that compared the different outcome definitions (Table 4-17), 79 hospitals (68%) of the 116 hospitals in the sample had mortality rates that were never in either the highest or the lowest deciles, regardless of which outcome was used. There were 8 hospitals (7% of all hospitals) with mortality rates in the highest decile no matter which of the three outcome definitions was used. Finally, there were 6 hospitals (5% of 116 hospitals) with death rates in the lowest decile for all 3 analyses that compared different ways of defining outcomes.

Similar results were obtained when comparing the three ways to handle transfers (Table 4-18). Among the 116 hospitals in the study, 83 (72%) were never included in either the highest or the lowest deciles. There were 9 hospitals (8% of all hospitals) with death rates in the highest decile across all three methods used to handle transfers, while there were 6 hospitals (5% of 116 hospitals) with death rates in the lowest decile, regardless of the analysis performed.

These results provide information regarding the consistency with which hospital mortality rates are in the highest or lowest deciles. It would, however, be inappropriate to evaluate hospital performance solely on whether or not hospital mortality rates fall in the highest or lowest deciles, since these methods do not take into account the degree of variability around each hospital-specific death rate. Estimates of hospital-specific

death rates may fall within the highest 10th percentile, but these may also have substantially wide confidence intervals. Identifying such hospitals as poor performers may therefore be misleading, since they would not be considered significantly different from other hospitals.

Rankings, based on hospital-specific adjusted death rates, used to identify significant outliers

When comparing hospital-specific adjusted death rates, it is important to take into account the precision of the rate for a specific hospital when measuring differences across hospitals. A typical approach used to conduct comparative studies of hospital performance is to identify specific hospitals with adjusted mortality rates that are significantly different from what would be expected by chance, given their case mix (88;91;106;112).

In light of this study's aim to determine whether hospitals are consistently rated as "better" or "worse" performers, regardless of how patient outcomes are defined and how transfers are handled, the variation between hospital mortality rates needed to be examined.

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Would a hospital be consistently identified as an "outlier" using different methods to define the study outcome and to deal with transfers?

The impact of the six analyses considered in this study was examined by determining whether or not the same hospitals were consistently identified as "significant" outliers, regardless of how the outcome was defined or how transfers were handled.

Empirical Bayes (EB) estimates for the deviation (μ_{oj}) of hospital-specific log odds of death from the overall intercept (γ_{oo}) were obtained from each of the six analyses done in HLM. Each of these hospital-specific

deviations was added to the corresponding overall death rate, giving 116 hospital-specific intercepts, (β_{0j}), or log odds of death, in the logit scale.

Hospital-specific death rates were then calculated using the conversion formula:

$$Death\ Rate_j = \frac{e^{\beta_{0j}}}{1+e^{\beta_{0j}}}$$

$$where\ \beta_{0j} = \gamma_{00} + \mu_{0j}$$

The 95% confidence interval around each hospital-specific death rate was estimated using the variance provided by HLM for each hospital's estimated deviation from the overall intercept:

$$SD_{hospital\ specific\ deviation\ from\ \gamma_{00}} = \sqrt{Variance\ of\ EB\ estimate\ \mu_{0j}}$$

and 95% range of hospital specific log odds of death was calculated as :

$$95\%\ range_{hospital\ specific\ death\ rate} = \frac{e^{\beta_{0j} \pm 1.96(SE(\beta_{0j}))}}{1+e^{\beta_{0j} \pm 1.96(SE(\beta_{0j}))}}$$

The estimated hospital-specific death rates obtained for each of the three analyses used to compare the impact of 3 different ways to define outcomes are provided in Appendix 16. Similarly, estimated death rates obtained for each of the three analyses used to compare the impact of 3 different ways to handle transfers are provided in Appendix 17. Hospital names are also provided in full for the reader in Appendix 18.

Using these data, plots were created for each of the six analyses separately. Each Empirical Bayes estimate for a hospital-specific death rate (with corresponding 95% confidence interval) was plotted in ascending order. These six plots were used to identify hospitals with death rates that were significantly different from the overall analysis-

specific death rate and its corresponding 95% confidence interval. These plots, sometimes referred to as "caterpillar plots" (231) because of their resemblance to a caterpillar, are illustrated in Figures 20 to 25.

"High outlier" hospitals were those whose adjusted mortality rate was significantly higher than the overall average range. These hospitals would typically be labelled as the worst performers. "Low outlier" hospitals were those with lower than expected adjusted mortality rates, and would be labelled as the best performers. The number of high and low outliers identified (worst and best performers respectively) varied among the six analyses (Appendix 19), and hospitals that were identified as "best" or "worst performers" varied somewhat across these analyses (Table 4-19).

When comparing the three methods used to define the study outcome, one hospital was identified as a "best performer" only once ('HPROVMAG' in Table 4-19). Another hospital, ('JGH') was consistently identified as a best performer regardless of the method used to define the outcome. Among the 8 hospitals identified as "worst performers", 5 were identified as such only once ('CHFLEURY', 'HDMTL', 'HDQUEBEC', 'HDSTJERO', 'HSANTACA'), 2 were identified twice ('HJEANTAL', 'HSTLUC'), and one hospital, 'HCHALEMO', was consistently identified as a "worst performer" regardless of the method used to define the time frame for outcome evaluation. Of the 116 included in the study, 106 were never identified as either a "high outlier" or a "low outlier" ("worst" or "best performer" respectively) regardless of the method used to define the outcome (Table 4-20).

When comparing the three different ways to handle transfers, 102 hospitals were never identified as either a "high" or "low outlier" (Table 4-21). There were 4 hospitals identified as "best performers" only once among the three analyses compared ('CHUNILAV', 'HLAVAL',

'HPROVMAG', 'INSTCARM' in Table 4-19). One hospital ('JGH') was identified as a best performer for two of these three analyses. No hospital was consistently identified as a best performer in all three analyses that compared the different ways of dealing with transfers. At the other end of the spectrum, 4 hospitals were identified as "worst" performers one time only ('HARGENTE', 'HGENLACH', 'HMAISROS', 'HSANTACA'), 2 hospitals were identified as "high outliers" in 2 of the 3 analyses ('CHFLEURY', 'HSTLUC') and 3 hospitals were consistently identified as "worst performers" ('HCHALEMO', 'HDSTJERO', 'HJEANTAL') regardless of the method used to handle transfers.

Differences between hospital-specific and overall mortality rates: are these clinically relevant?

Studies that compare quality of care across hospitals traditionally rely on identifying statistical differences in the levels of performance indicators (90). However, absolute differences in hospital mortality rates can also provide information on the clinical relevance of inter-hospital differences.

The estimated variance (τ_{00}) around the overall hospital mortality rate was used earlier (Results section: "Variation in Death Rates Between Hospitals, Chance or Not?" pg 107) to display the variation in the expected hospital mortality rates for each of the six analyses (Figure 4-15). The absolute differences between estimated hospital-specific mortality rates can also be used to illustrate the clinical relevance of inter-hospital differences. Table 4-22 presents the maximum differences between estimated hospital-specific and overall mortality rates for each of the analyses performed in this study. The largest difference between the highest hospital-specific mortality rate and the overall rate is 3.19%, which is estimated in the analysis that excludes transfers and uses in-hospital

mortality as the outcome (this mortality rate corresponds to the hospital "HSTLUC" in Figure 4-20). The largest absolute difference between the lowest hospital-specific mortality rate and the overall rate is 3.62%, which belongs to "HPROVMAG" (Figure 4-24) in the analysis where transfers are assigned to the initial hospital and "death at 30-days post-AMI admission" is used as the outcome.

The smallest differences between the overall mortality rate and the highest as well as the lowest hospital-specific mortality rates (1.88% and 2.08% respectively) are both obtained in the analysis that excludes transfers and uses death at 7 days post-AMI admission as the outcome. The hospitals with these highest and lowest mortality rates are "HDQUEBEC " and "JGH" respectively (Figure 4-21).

Figure 4-26 plots the distribution of the differences between hospital-specific mortality rate estimates and overall mortality rate for each of the six analyses. Most differences between hospital-specific mortality rates and the overall rate are within 1.5%, illustrating that, for most hospitals, the hospital-specific mortality rate is not substantially different from the overall rate.

Tables and Figures pertaining to Chapter 4

Table 4-1: 30-day post-AMI index admission death rate, transfers included, unadjusted, by year. Quebec acute hospitals 1992-1999

30-day mortality outcome	1992		1993		1994		1995		1996		1997		1998		1999		Total	
Alive	10,203	87%	10,186	86%	9,954	86%	10,027	86%	10,128	87%	9,969	87%	9,614	87%	9,552	88%	79,633	87%
Dead	1,512	13%	1,604	14%	1,622	14%	1,575	14%	1,498	13%	1,467	13%	1,422	13%	1,300	12%	12,000	13%
Total	11,715	100%	11,790	100%	11,576	100%	11,602	100%	11,626	100%	11,436	100%	11,036	100%	10,852	100%	91,633	100%

Table 4-2: Average length of stay in days, AMI index admission and episode of care, Quebec acute care hospitals, 1992-1999

	1992	1993	1994	1995	1996	1997	1998	1999
Index admission	11.9	11.7	11.3	10.5	10.0	9.6	9.4	9.3
Episode of care*	13.7	13.3	12.9	12.4	11.7	11.5	11.1	11.1

* an episode of care consists of one or more consecutive admissions

Table 4-3: Characteristics of patients admitted for acute myocardial infarction, by hospital AMI volume and revascularization facilities

		Type of Facility and Volume of AMI Index Admissions				
	Availability of revsacularization facilities	No revascularization	No revascularization	No revascularization	Revascularization	All patients
	AMI volume of index AMI admissions during study period[1]	< 400 admissions (average: <50 per year)	400-999 admissions (50 to <125 per year)	1000+ admissions (125 or more per year)	Any size	
Number (%) of index admissions by hospital category		8658 (9.4%)	16647 (18.2%)	49766 (54.3%)	16562 (18.1%)	91633 (100%)
Age	90th percentile	83	83	83	83	83
	75th percentile	77	76	76	76	76
	median	68	67	67	67	67
	25th percentile	56	56	55	56	55
	10th percentile	46	47	47	47	47
	Mean	66	66	65	66	66
Gender	women	35%	35%	35%	34%	35%
	men	65%	65%	65%	66%	65%
Comorbidity Score[2]	0	45%	46%	44%	44%	45%
	1	28%	28%	28%	28%	28%
	2	14%	14%	14%	14%	14%
	3	7%	7%	7%	7%	7%
	4	3%	3%	4%	4%	3%
	> 4	2%	2%	3%	3%	3%
Low SES[3] (neighbourhood)	90th percentile (lowest SES)	35.5%	34.1%	41.0%	51.8%	41.5%
	75th percentile	24.6%	23.4%	27.8%	40.6%	28.8%
	median	19.5%	19.5%	20.8%	27.4%	20.7%
	25th percentile	17.0%	17.1%	15.9%	18.4%	16.4%
	10th percentile	15.0%	14.9%	13.9%	14.2%	14.2%
	Mean	22.1%	21.9%	23.6%	29.9%	24.3%
Distance to tertiary care (km)	90th percentile	656	261	124	44	165
	75th percentile	467	120	69	13	83
	median	160	80	23	4	23
	25th percentile	69	20	6	2	5
	10th percentile	4	4	3	1	2
	Mean	274	116	46	18	75

[1] These figures underestimate the total number of AMI patients treated in each hospital, since a single patient may be treated in more than one hospital. These figures represent "new" AMI cases only.
[2] Comorbidity score was obtained using the Romano-Roos adaptation of the Charlson comorbidity Index
[3] Low SES variable represents the proportion of the population in the patient's FSA (Forward Sortation Area: defined by the 1st 3 digits of the postal code) whose household income is below the LICO (Low income cut off). For example, a Low SES value of 25% indicates that 25% of the people residing in the patient's FSA have a household income that falls below the LICO (Low income cut off).

Table 4-4: Characteristics of new AMI patients admitted to Quebec acute care hospitals, who were or were not subsequently transferred (1992-1999)

		Patient transferred		All patients
		No	Yes	
Index admissions by transfer status	number (n)	78,113	13,520	91,633
	proportion (%)	85%	15%	
Age	90th percentile	84	75	
	75th percentile	77	69	
	median	68	61	
	25th percentile	56	51	
	10th percentile	47	44	
	Mean	67	60	
Gender	women	36%	28%	
	men	64%	72%	
Comorbidity Score*	0	43%	55%	
	1	28%	27%	
	2	14%	11%	
	3	7%	4%	
	4	4%	2%	
	> 4	3%	1%	
Low SES ¤	90th percentile (Lowest SES)	41.5%	37.2%	
	75th percentile	29.3%	25.6%	
	median	21.0%	19.5%	
	25th percentile	16.7%	15.8%	
	10th percentile	14.2%	13.6%	
	Mean	24.7%	22.2%	
Distance to tertiary care (km)	90th percentile	165	261	
	75th percentile	80	111	
	median	22	38	
	25th percentile	5	9	
	10th percentile	2	3	
	Mean	72	94	
Outcome at 30 days post AMI admission	dead	15%	4%	13%
	alive	85%	96%	87%
Proportion of patients transferred to another hospital, by type of facility	<400 admissions no revascularization facility	82%	18%	
	400-999 admissions no revascularization facility	82%	18%	
	1000+ admissions no revascularization facility	82%	18%	
	Hospitals with revascularization facilities	99%	1%	

* comorbidity score was obtained using the Romano-Roos adaptation of the Charlson comorbidity Index
¤ Low SES variable represents the proportion of the population in the patient's FSA (Forward Sortation Area: defined by the 1st 3 digits of the postal code) whose household income is below the LICO (Low income cut off). For example, a Low SES value of 25% indicates that 25% of the people residing in the patient's FSA have a household income that falls below the LICO (Low income cut off).

Table 4-5: Hospital profiles for 116 Quebec acute care hospitals that admitted new AMI patients between 1992-1999, according to hospital AMI volume and availability of revascularization facilities

Availability of revascularization AMI volume (# index AMI admissions during study period)		Type of Facility and Volume of AMI Index Admissions No revascularization < 400 admissions (average: <50 per year)	No revascularization 400-999 admissions (50 to <125 per year)	No revascularization 1000+ admissions (125 or more per year)	Revascularization Any size	All hospitals combined
Number (%) of hospitals in category		46 (40%)	26 (22%)	32 (28%)	12 (10%)	116 (100%)
Mean Patient Age by hospital	90th percentile	75	69	68	67	83
	median	67	65	66	66	67
	10th percentile	61	63	63	64	47
	Mean	67	66	66	66	66
Proportion of women by hospital	90th percentile	50%	41%	40%	40%	43%
	median	35%	34%	34%	35%	34%
	10th percentile	25%	31%	32%	29%	28%
	Mean	35%	35%	35%	35%	35%
Comorbidity Score by hospital[4]	90th percentile	1.6	1.2	1.4	1.4	1.4
	median	1.1	1.0	1.1	1.0	1.0
	10th percentile	0.7	0.8	0.9	0.9	0.8
Low SES by hospital[5]	90th percentile (lowest)	33%	30%	35%	40%	42%
	median	19%	20%	21%	32%	21%
	10th percentile	15%	17%	18%	20%	14%
	Mean	21%	22%	24%	31%	24%
Mean distance to tertiary care centre, by hospital (km)	90th percentile	687	398	122	36	482
	median	178	70	29	14	67
	10th percentile	14	12	8	9	10
	Mean	406	120	51	18	204
Crude death rate by hospital (death at 30 days post AMI admission)	90th percentile	21.1%	16.2%	17.9%	16.9%	18.8%
	median	13.4%	12.3%	13.4%	13.6%	13.6%
	10th percentile	4.2%	9.3%	10.1%	9.2%	9.1%
	Mean	13.4%	12.3%	13.7%	13.1%	13.2%

[4] Comorbidity score was obtained using the Romano-Roos adaptation of the Charlson comorbidity Index

[5] Low SES variable represents the proportion of the population in the patient's FSA (Forward Sortation Area: defined by the 1st 3 digits of the postal code) whose household income is below the LICO (Low income cut off). For example, a Low SES value of 25% indicates that 25% of the people residing in the patient's FSA have a household income that falls below the LICO (Low income cut off).

Table 4-6: Univariate models used to select variables for full models

Univariate models

Variables considered for comparing hospital performance ranks (for AMI admissions excluding transfers) using three methods to define outcome

	Variable	In hospital death			Death within 7 days post-AMI admission			Death within 30 days post-AMI admission		
		Beta coeff	s.e.	p-value	Beta coeff	s.e.	p-value	Beta coeff	s.e.	p-value
Level 1 Variables	Age	0.074	0.001	0.000	0.066	0.001	0.000	0.072	0.001	0.000
	Female	0.716	0.020	0.000	0.681	0.024	0.000	0.678	0.021	0.000
	Comorbidity	0.314	0.010	0.000	0.201	0.010	0.000	0.304	0.010	0.000
	Low SES	0.010	0.001	0.000	0.009	0.002	0.000	0.009	0.001	0.000
	> 10 km to tertiary care centre	-0.160	0.030	0.000	-0.171	0.034	0.000	-0.148	0.030	0.000
Level 2 Variables	Teaching hospital	-0.036	0.057	0.534	-0.046	0.056	0.417	-0.016	0.059	0.792
	PTCA facilities	-0.035	0.160	0.828	-0.019	0.153	0.901	-0.035	0.164	0.829
	CABG and PTCA facilities	-0.205	0.081	0.012	-0.245	0.077	0.002	-0.176	0.085	0.037

Variables considered for comparing hospital performance ranks (for deaths within 30 days) using three methods to deal with transfers

	Variable	Exclude transfers			Include transfers assign to hospital1			Include transfers assign to hospital2		
		Beta coeff	s.e.	p-value	Beta coeff	s.e.	p-value	Beta coeff	s.e.	p-value
Level 1 Variables	Age	0.072	0.001	0.000	0.076	0.001	0.000	0.074	0.001	0.000
	Female	0.678	0.021	0.000	0.714	0.020	0.000	0.689	0.020	0.000
	Comorbidity	0.304	0.010	0.000	0.334	0.009	0.000	0.309	0.010	0.000
	Low SES	0.009	0.001	0.000	0.011	0.001	0.000	0.012	0.002	0.000
	> 10 km to tertiary care centre	-0.148	0.030	0.000	-0.154	0.036	0.000	-0.212	0.048	0.000
Level 2 Variables	Teaching hospital	-0.016	0.059	0.792	0.005	0.057	0.929	-0.066	0.069	0.339
	PTCA facilities	-0.035	0.164	0.829	-0.035	0.159	0.828	-0.052	0.198	0.792
	CABG and PTCA facilities	-0.176	0.085	0.037	-0.024	0.084	0.773	-0.540	0.084	0.000

Shaded cells indicate variable was not significant at p<0.01

Table 4-7: Summary results – variables selected for all analyses

Six Analyses	Variables							
	Patient Level					Hospital Level		
	Age	Female	Comorbidity	Low SES	Distance to tertiary centre	Teaching status	PTCA* Facility	CABG and PTCA facility
3 ways to define outcomes								
In-hospital deaths Transfers excluded	+	+	+	+	+	x	x	+
Death at 7 days post-AMI Transfers excluded	+	+	+	+	+	x	x	+
Death at 30 days post-AMI Transfers excluded	+	+	+	+	+	x	x	+
3 ways to deal with transfers								
Death at 30 days post-AMI Transfers excluded	+	+	+	+	+	x	x	+
Death at 30 days post-AMI Transfers assigned to initial hospital	+	+	+	+	+	x	x	x
Death at 30 days post-AMI Transfers assigned to receiving hospital	+	+	+	+	+	x	x	+

Variable was independently significant at $p < 0.01$ +

Variable was not independently significant at $p < 0.01$ x

NOTE: variable PTCA* was not independently significant, but this is an indicator variable used in conjunction with CABG

Table 4-8: Variation in covariates between hospitals

Covariate used as outcome*	Grand mean value	τ_{00} (Variance of hospital-specific intercepts around overall mean value)	p-value
Age	67.239	8.311	0.000
Gender {logit p(female)}	-0.562	0.035	0.000
Gender** (proportion of patients who are female)	0.363	----------	----------
Comorbidity	1.105	0.053	0.000
Low SES	23.179	53.036	0.000
Distance to nearest tertiary care centre (continuous)	203.886	161,275.386	0.000

* Results reported above were obtained by modelling each covariate as the dependent variable, hospitals as level 2 predictors, with no other variables included in the models

Model:

$$Covariate = \beta_0 + r$$
$$Where: \ \beta_0 = \gamma_{00} + \mu_0$$
$$\mu_0 \approx N(0, \tau_{00})$$

** Converted from logit(p) to proportion

Shaded cells report values in logit scale

Table 4-9: Beta coefficients for candidate variables for fully adjusted models

Univariate models

Variables used in models comparing hospital performance ranks (for AMI admissions excluding transfers) using three methods to define outcome

		In hospital death			Death within 7 days post-AMI admission			Death within 30 days post-AMI admission		
	Variable	Beta coeff	s.e.	p-value	Beta coeff	s.e.	p-value	Beta coeff	s.e.	p-value
Level 1 Variables	Age	0.07	0.00	0.000	0.06	0.00	0.000	0.06	0.00	0.000
	Female	0.25	0.02	0.000	0.23	0.03	0.000	0.21	0.02	0.000
	Comorbidity	0.19	0.01	0.000	0.07	0.01	0.000	0.18	0.01	0.000
	Low SES	0.01	0.00	0.000	0.01	0.00	0.000	0.01	0.00	0.000
	> 10 km to tertiary care centre	-0.02	0.04	0.627	-0.04	0.04	0.320	-0.01	0.04	0.875
Level 2 Variables	PTCA facilities	0.00	0.12	0.996	0.00	0.11	0.980	0.00	0.12	0.924
	CABG and PTCA facilities	-0.21	0.06	0.002	-0.25	0.06	0.000	-0.17	0.07	0.011

Variables used in models comparing hospital performance ranks (for deaths within 30 days) using three methods to deal with transfers

		Exclude transfers			Include transfers assign to hospital1			Include transfers assign to hospital2		
	Variable	Beta coeff	s.e.	p-value	Beta coeff	s.e.	p-value	Beta coeff	s.e.	p-value
Level 1 Variables	Age	0.06	0.00	0.000	0.07	0.00	0.000	0.07	0.00	0.000
	Female	0.21	0.02	0.000	0.23	0.02	0.000	0.22	0.02	0.000
	Comorbidity	0.18	0.01	0.000	0.20	0.01	0.000	0.18	0.01	0.000
	Low SES	0.01	0.00	0.000	0.01	0.00	0.000	0.01	0.00	0.000
	> 10 km to tertiary care centre	-0.01	0.04	0.875	0.00	0.04	0.980	-1.08	0.03	0.002
Level 2 Variables	PTCA facilities	0.00	0.12	0.924	0.01	0.12	0.943	-0.10	0.11	0.380
	CABG and PTCA facilities	-0.17	0.07	0.011	-0.09	0.07	0.157	-0.41	0.06	0.000

Shaded cells indicate variable ws not significant at $p<0.01$

Interpretation of the Beta coefficients, using age as an example: for a 1-year increase in age, the log-odds of in-hospital death increases by 0.07.

Table 4-10: Estimated variance (τ_{00}) in the log odds of death for six analyses, using 3 models

This table presents the variation in the hospital-specific log odds of death [in logit scale: logit(p)] for 3 analyses that compare outcomes, and for 3 analyses that compare how transfers are handled.

		Variation in the hospital-specific log odds of death, τ_{00} according to 3 models[6]				**Portion of total variation that is explained by patient and hospital characteristics[7]** $\text{portion of total variation explained} = \frac{\tau_{00}(crude) - \tau_{00}(adjusted)}{\tau_{00}(crude)}$
		No adjustments CRUDE Models	Adjustment for patient characteristics	Adjustment for patient & hospital characteristics FULL Models		
Analyses using 3 ways to define outcomes		Variance τ_{00}	Variance τ_{00}	Variance τ_{00}	p-value	
Excluding all transfers	In-hospital death	0.067	0.037	0.031	0.000	55%
	Death 7-days post-AMI	0.059	0.033	0.024	0.000	59%
	Death 30-days post-AMI	0.071	0.036	0.032	0.000	55%
Analyses using 3 ways to handle transfers						
Using Death at 30 days post admission	Exclude all transfers	0.071	0.036	0.032	0.000	55%
	Include transfers, assign to initial hospital	0.066	0.034	0.033	0.000	50%
	Include transfers, assign to receiving hospital	0.106	0.053	0.030	0.000	72%

[6] The variation in the hospital-specific log odds of death is presented for three different scenarios: One scenario does not take patient or hospital characteristics into account; the second takes patient characteristics alone into account; the third takes patient and hospital characteristics into account.

[7] The portion of variation in log odds of death between hospitals that is explained by both patient and hospital factors is calculated using the equation illustrated above. It is expressed as a proportion of the total variation. The denominator, or the total variation, is the variation estimated between hospital in the crude model, as it is the variation in hospital log odds of death before accounting for patient or hospital characteristics.

Table 4-11: Hospital-specific adjusted mortality rates and range across hospitals using three ways to define outcomes

Timeframe used for outcome evaluation	Average hospital-specific adjusted mortality rate (%)	Mortality Rate Spread Across Hospitals		
		Minimum	Maximum	Spread
In-hospital	11.2%	8%	14.7%	6.7%
7-days	7.8%	5.9%	9.9%	4.0%
30-days	11.0%	8.6%	14.1%	5.5%

Table 4-12: Hospital-specific adjusted mortality rates and range across hospitals using three ways to deal with transfers

Method used to deal with transfers	Average hospital-specific adjusted mortality rate (%)	Mortality Rate Spread Across Hospitals		
		Minimum	Maximum	Spread
Transfers excluded	11.0%	8.6%	14.2%	5.6%
Transfers included, assign to initial hospital	10.2%	7.7%	13.8%	6.1%
Transfers included, assign to receiving hospital	10.2%	7.6%	13.3%	5.7%

Table 4-13: Correlation of hospital ranks using three methods to define outcomes, transfers excluded

Outcome definition	In-hospital death	Death at 7 days post-AMI admission	Death at 30 days post-AMI admission
In-hospital death	1	0.858	0.875
Death at 7 days post-AMI admission	0.858	1	0.925
Death at 30 days post-AMI admission	0.875	0.925	1

Table 4-14: Correlation of hospital ranks using three methods to deal with transfers, using death at 30 days post-AMI admission as common outcome

Method used to deal with transfers	Exclude Transfers	Include transfers, assign outcome to initial hospital	Include transfers, assign outcome to receiving hospital
Exclude Transfers	1	0.964	0.972
Include transfers, assign outcome to initial hospital	0.964	1	0.931
Include transfers, assign outcome to receiving hospital	0.972	0.931	1

Table 4-15: Concordance in quintile classification for pairwise comparisons of 3 ways to define outcome (transferred patients excluded)

Comparing ways to define outcomes	Change in number of quintiles[8]: # quintiles moved down[9] (better performance) -4	-3	-2	-1	No change 0	# quintiles moved up (worse performance) 1	2	3	4	Total hospitals
	Number of hospitals changing quintiles (n, %)									
Change in quintile from 1: **In-hospital deaths** To 2: **Death at 7 days post AMI**	0	0	6	19	66	21	2	2	0	116
	0%	*0%*	*5%*	*16%*	*57%*	*18%*	*2%*	*2%*	*0%*	*100%*
Change in quintile from 1: **In-hospital deaths** To 3: **Death at 30 days post AMI**	0	0	2	22	73	13	5	1	0	116
	0%	*0%*	*2%*	*19%*	*63%*	*11%*	*4%*	*1%*	*0%*	*100%*
Change in quintile from 2: **Death at 7 days post AMI** To 3: **Death at 30 days post AMI**	0	0	1	19	76	19	1	0	0	116
	0%	*0%*	*1%*	*16%*	*66%*	*16%*	*1%*	*0%*	*0%*	*100%*

Table 4-16: Concordance in quintile classification for pairwise comparisons of 3 ways to handle transfers (using death at 30 days post-AMI as outcome)

Comparing ways to handle transfers	Change in number of quintiles: # quintiles moved down (better performance) -4	-3	-2	-1	No change 0	# quintiles moved up (worse performance) 1	2	3	4	Total hospitals
	Number of hospitals changing quintiles (n, %)									
Change in quintile from 1: **Exclude transfers** To 2: **Assign transfers to Hospital 1**	0	0	0	16	85	14	1	0	0	116
	0%	*0%*	*0%*	*14%*	*73%*	*12%*	*1%*	*0%*	*0%*	*100%*
Change in quintile from 1: **Exclude transfers** To 3: **Assign transfers to Hospital 2**	0	0	0	14	89	12	1	0	0	116
	0%	*0%*	*0%*	*12%*	*77%*	*10%*	*1%*	*0%*	*0%*	*100%*
Change in quintile from 2: **Assign transfers to Hospital 1** To 3: **Assign transfers to Hospital 2**	0	0	2	16	79	18	1	0	0	116
	0%	*0%*	*2%*	*14%*	*68%*	*16%*	*1%*	*0%*	*0%*	*100%*

[8] Interpreting the change in number of quintiles, illustrated for the first comparison, using hospital ranks obtained with in-hospital deaths or with death at 7 days post-AMI admission: 66 hospitals did not change their quintile rank; 21 hospitals ranked 1 quintile higher when death at 7 days was used, compared with in-hospital deaths; 19 hospitals ranked 1 quintile lower when using death at 7-days compared to using in-hospital deaths.

[9] Quintile 1 contains the lowest 20% of hospital mortality rates, representing better outcomes. In contrast, quintile 5 contains the highest 20% of hospital mortality rates, representing worse outcomes. A positive change in the number of quintile means that a hospital had a higher mortality rate using the second of the two methods compared. A negative change in quintile means that a hospital had a higher mortality rate using the first of the two methods compared.

Table 4-17: Hospital mortality rates within the highest or lowest deciles, compared across 3 ways to define outcomes

	# times hospital is rated in the HIGHEST decile (worst performance) using 3 different ways to define outcomes[10]	# hospitals	
	never (0)	99	85%
	1 time	6	5%
	2 times	3	3%
	all 3 times	8	7%
	Total # of hospitals	*116*	*100%*
	# times hospital rated in the LOWEST decile (best performance) using 3 different ways to define outcomes	**# hospitals**	
	never (0)	96	83%
	1 time	10	9%
	2 times	4	3%
	all 3 times	6	5%
	Total # of hospitals	*116*	*100%*
	# hospitals with mortality rates that are in NEITHER highest NOR lowest deciles using 3 different ways to define outcomes	79	68%

Table 4-18: Hospital mortality rates within the highest or lowest deciles, compared across 3 ways to handle transfers

	# times hospital is rated in the HIGHEST decile (worst performance) using 3 different ways to handle transfers	# hospitals	
	never (0)	101	87%
	1 time	3	3%
	2 times	3	3%
	all 3 times	9	8%
	Total # of hospitals	*116*	*100%*
	# times hospital is rated in the LOWEST decile (best performance) using 3 different ways to handle transfers	**# hospitals**	
	never (0)	98	84%
	1 time	6	5%
	2 times	6	5%
	all 3 times	6	5%
	Total # of hospitals	*116*	*100%*
	# hospitals with mortality rates that are in NEITHER highest NOR lowest deciles using 3 different ways to handle transfers	83	72%

[10] This column displays the number of times a hospital mortality rate is in the highest (or lowest) decile, using three ways to define outcomes or three ways to handle transfers. For example, there were 6 hospitals with mortality rates falling in the highest decile using one of the 3 ways to define outcomes. Another example is that there were 6 hospitals with mortality rates in the lowest deciles, no matter how outcomes were defined.

Table 4-19: Hospitals identified as outliers, according to HLM analysis

Six HLM analyses, defined according to methods used to define outcome and to handle transfers

Hospital ID N=116	Transfers Excluded			# times HIGH outlier	# times LOW outlier
	In-hospital Death	Death at 7 days post AMI admission	Death at 30 days post AMI admission		
CHFLEURY			H	1	
HDMTL	H			1	
HDQUEBEC		H		1	
HDSTJERO			H	1	
HSANTACA	H			1	
HJEANTAL	H		H	2	
HSTLUC	H		H	2	
HCHALEMO	H	H	H	3	
HPROVMAG	L				1
JGH	L	L	L		3
# high outliers	**5**	**2**	**5**		
# low outliers	**2**	**1**	**1**		

Hospital ID N=116	Death at 30 days post AMI admission			# times HIGH outlier	# times LOW outlier
	Exclude Transfers	Include Transfers assign to Hospital 1	Include Transfers assign to Hospital 2		
HARGENTE		H		1	
HGENLACH		H		1	
HMAISROS			H	1	
HSANTACA		H		1	
CHFLEURY	H	H		2	
HSTLUC	H	H		2	
HCHALEMO	H	H	H	3	
HDSTJERO	H	H	H	3	
HJEANTAL	H	H	H	3	
CHUNILAV		L			1
HLAVAL			L		1
HPROVMAG		L			1
INSTCARM			L		1
JGH	L	L			2
# high outliers	**5**	**8**	**4**		
# low outliers	**1**	**3**	**2**		

Legend for Significant Outlier Status
H = High outlier (worst performer)
L = Low outlier (best performer)
Shaded cell = not an outlier

Table 4-20: Summary Table of Outlier Status - comparing 3 ways to define outcome

106 hospitals never identified as EITHER high or low outlier

Hospitals identified as significantly high outliers (worst performers)

108	hospitals never identified as high outlier
5	identified 1 time as a high outlier
2	identified 2 times as a high outlier
1	identified 3 times as a high outlier
116	Total hospitals

Hospitals identified as significantly low outliers (best performers)

114	hospitals never identified as low outlier
1	identified 1 time as a low outlier
0	identified 2 times as a low outlier
1	identified 3 times as a low outlier
116	Total hospitals

Table 4-21: Summary Table of Outlier Status - comparing 3 ways to handle transfers

102 hospitals never identified as EITHER high or low outlier

Hospitals identified as significantly high outliers (worst performers)

107	hospitals never identified as high outlier
4	identified 1 time as a high outlier
2	identified 2 times as a high outlier
3	identified 3 times as a high outlier
116	Total hospitals

Hospitals identified as significantly low outliers (best performers)

111	hospitals never identified as low outlier
4	identified 1 time as a low outlier
1	identified 2 times as a low outlier
0	identified 3 times as a low outlier
116	Total hospitals

Table 4-22: Distribution of differences between hospital-specific and overall mortality rates

	Exclude transfers In-hospital deaths	Exclude transfers Death at 7 days post AMI admission	Exclude transfers Death at 30 days post-AMI admission	Include transfers assign to initial hospital Death at 30 days post-AMI admission	Include transfers assign to receiving hospital Death at 30 days post-AMI admission
Average difference	-0.06%	-0.03%	-0.07%	-0.07%	-0.06%
Median difference	0.01%	0.02%	0.08%	0.05%	0.06%
sd	1.30%	0.76%	1.32%	1.29%	1.18%
difference between **HIGHEST hospital** mortality rate and **overall** mortality rate	**3.19%**	**1.88%**	2.37%	2.43%	2.55%
difference between **LOWEST hospital** mortality rate and **overall** mortality rate	-3.50%	**-2.08%**	-3.26%	**-3.62%**	-3.15%

Compare outcomes

Compare how to deal with transfers

Figure 4-1: Mean LOS (length of stay) of AMI patients by hospital
Quebec acute care hospitals 1992-1999

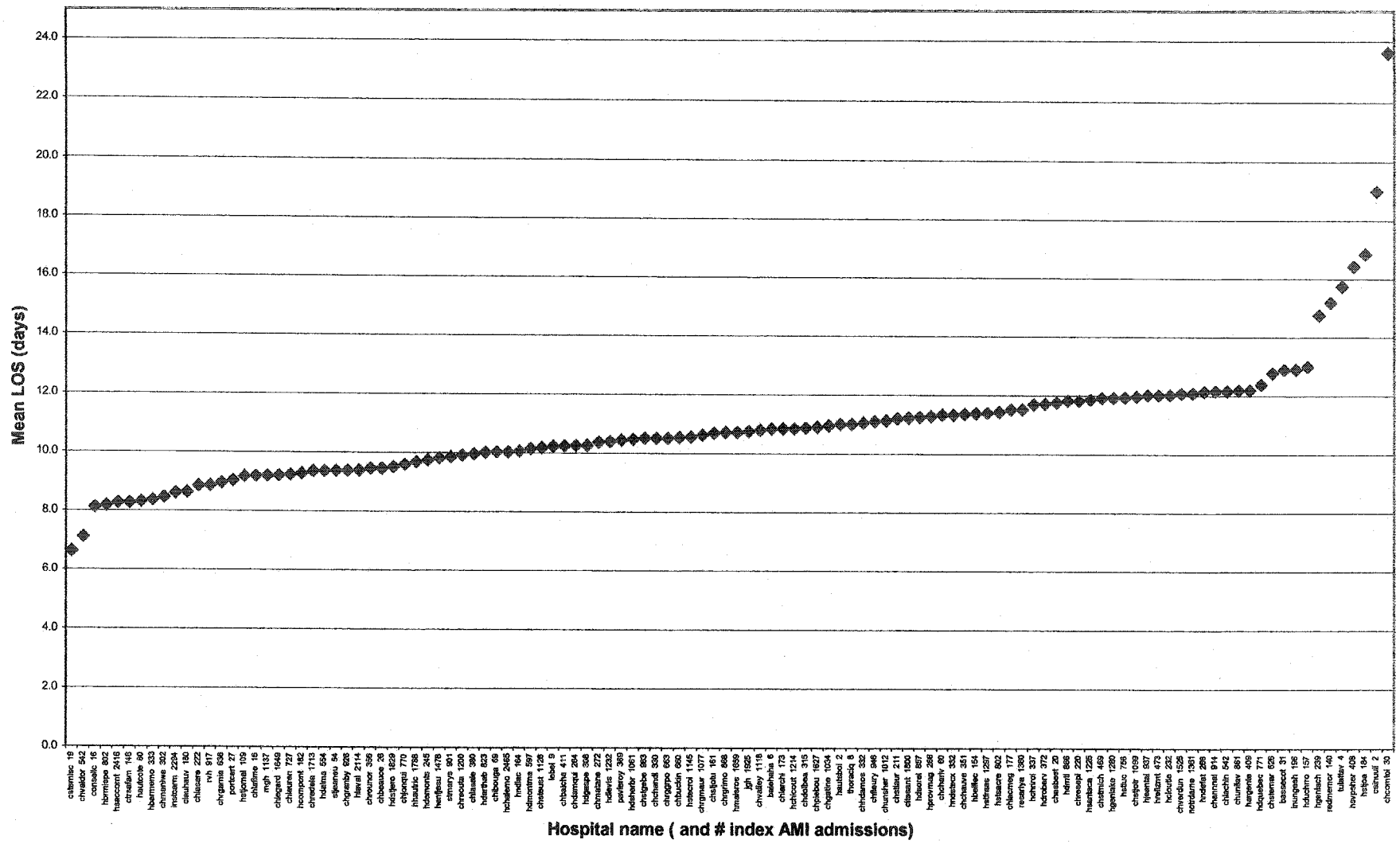


Figure 4-2: Proportion of AMI index admissions leading to a transfer

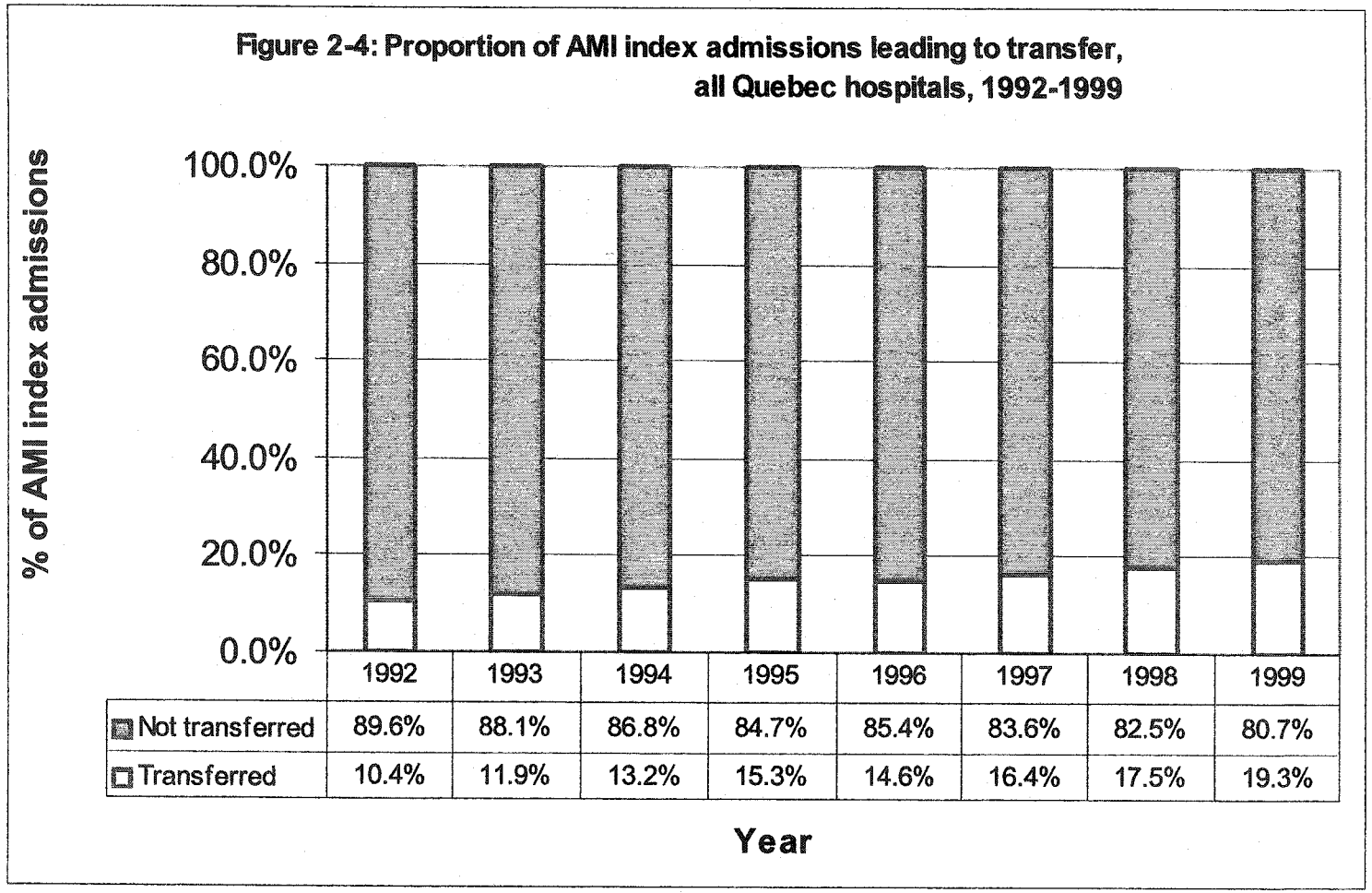


Figure 4-3: Mean age of AMI patients by hospital
Quebec acute care hospitals 1992-1999

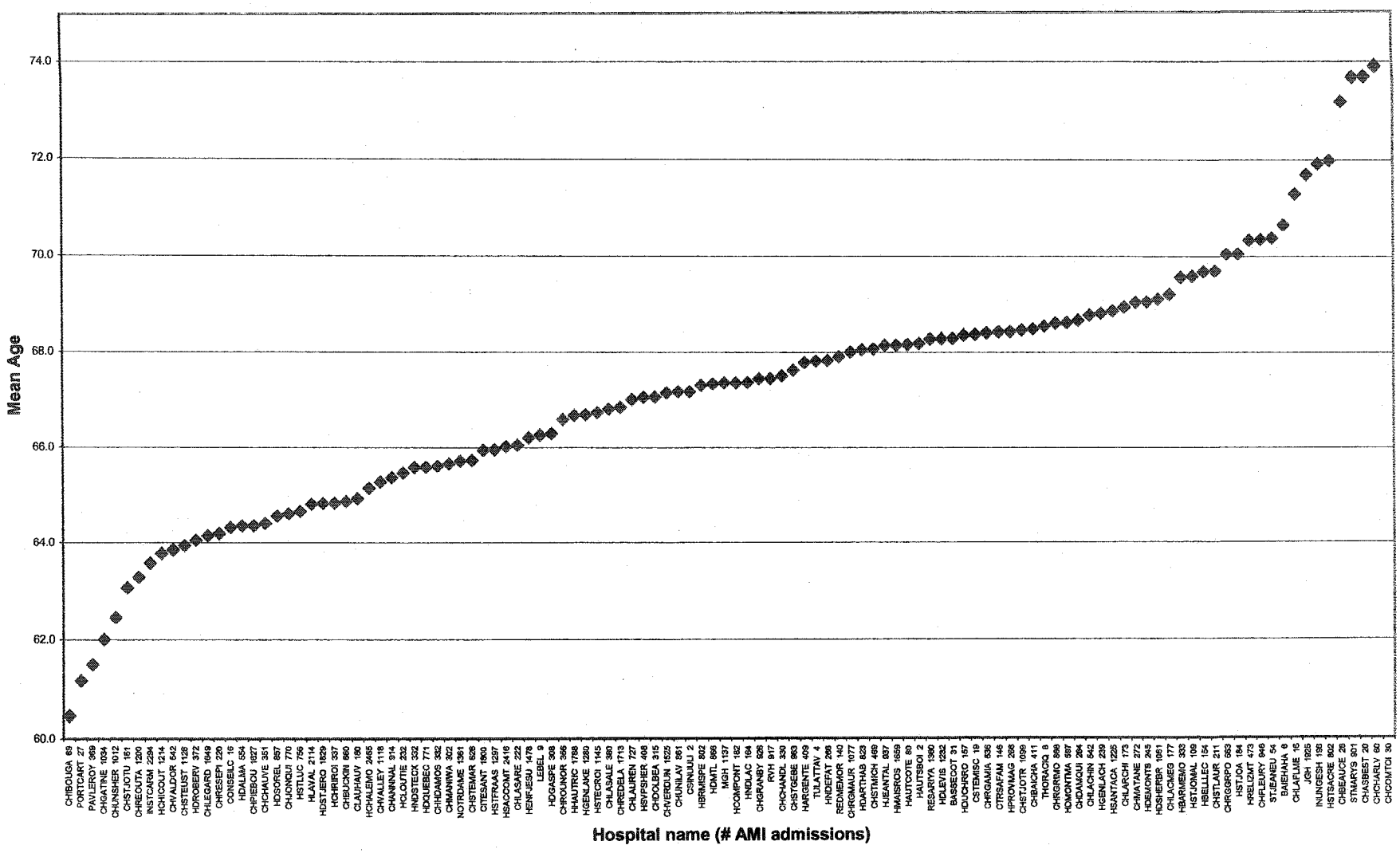


Figure 4-4: Proportion of AMI patients who are female, by hospital
Quebec acute care hospitals 1992-1999

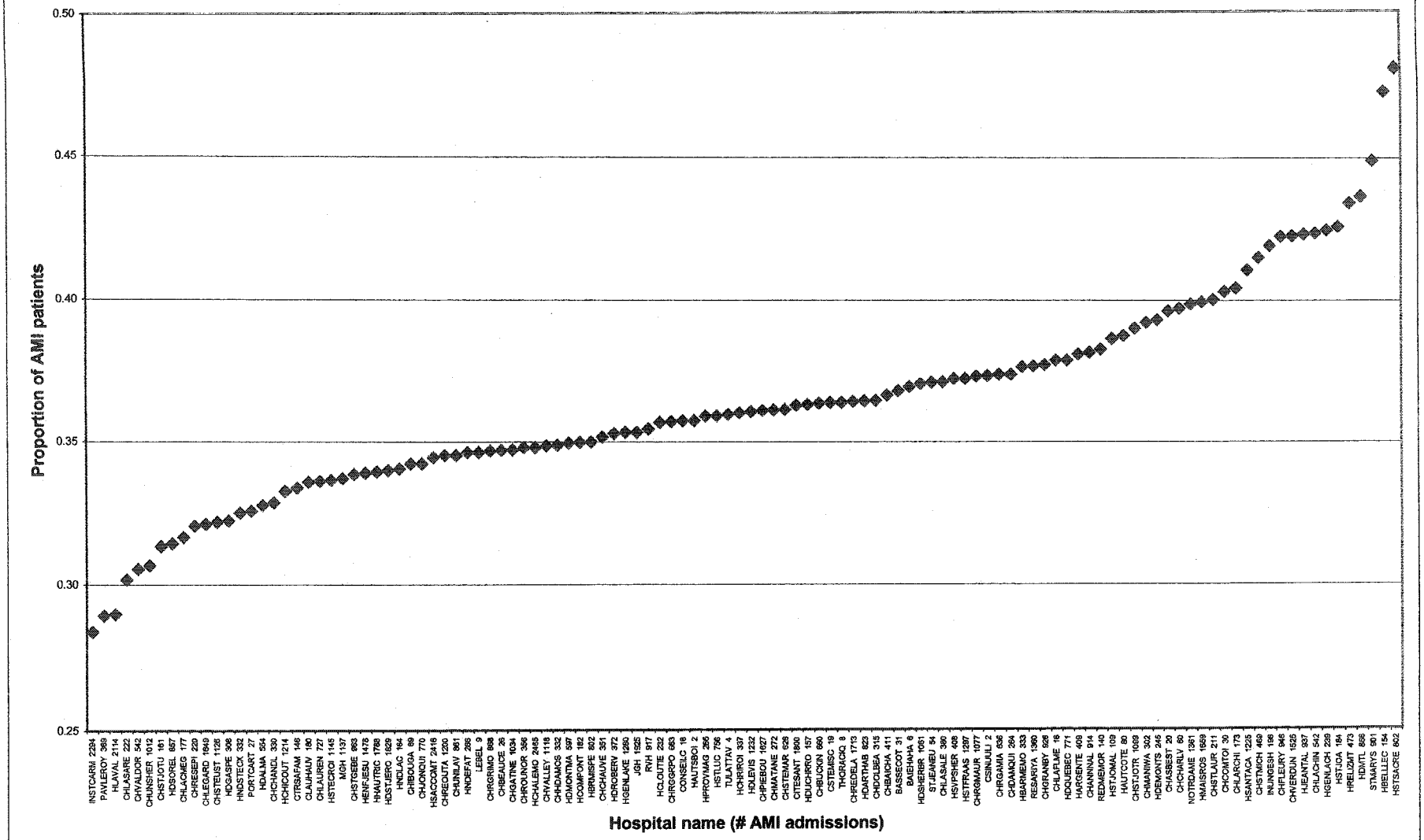


Figure 4-5: Mean comorbidity index score of AMI patients by hospital
Quebec acute care hospitals 1992-1999

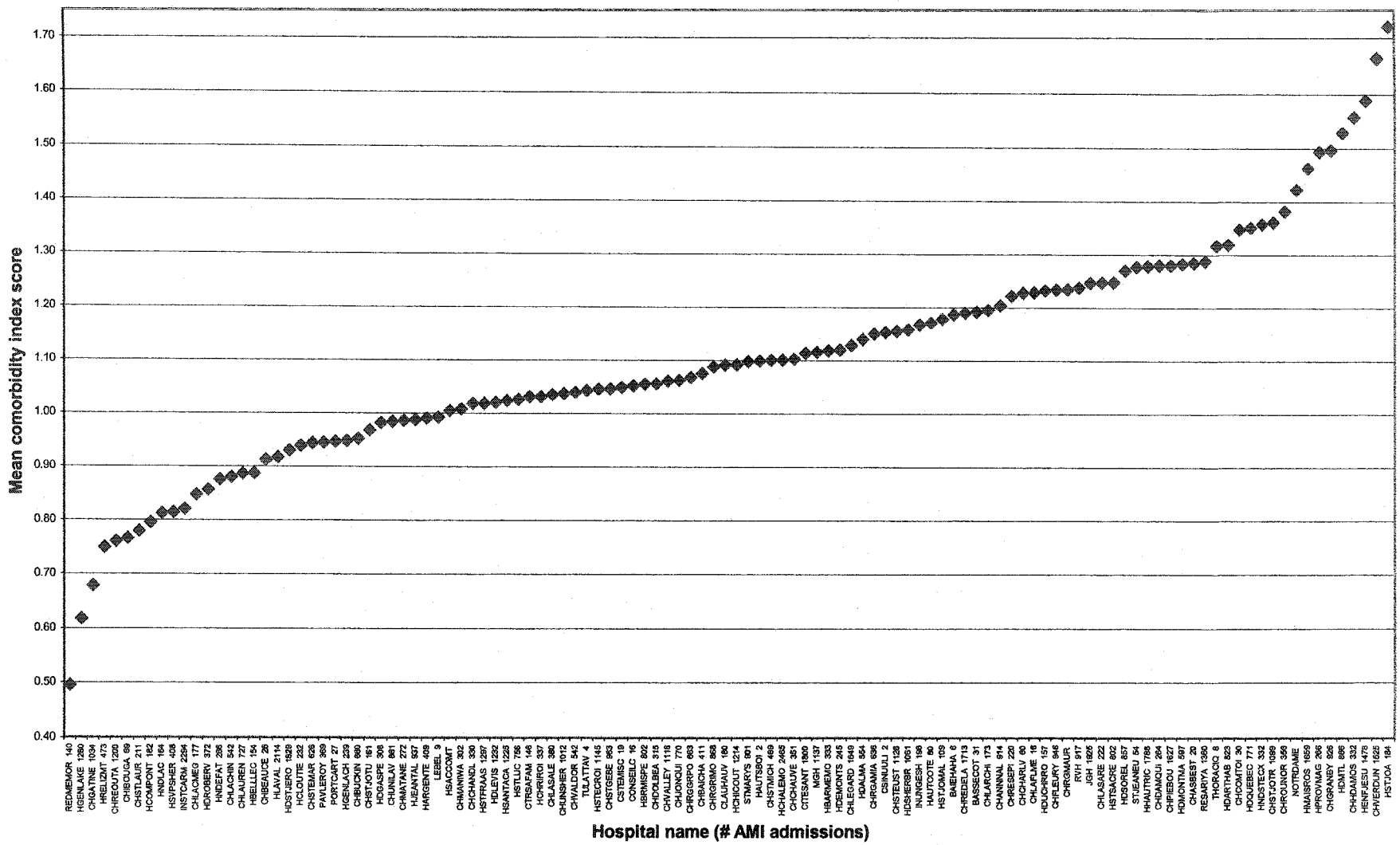


Figure 4-6: Mean comorbidity index score of AMI patients by hospital, age adjusted
Quebec acute care hospitals 1992-1999

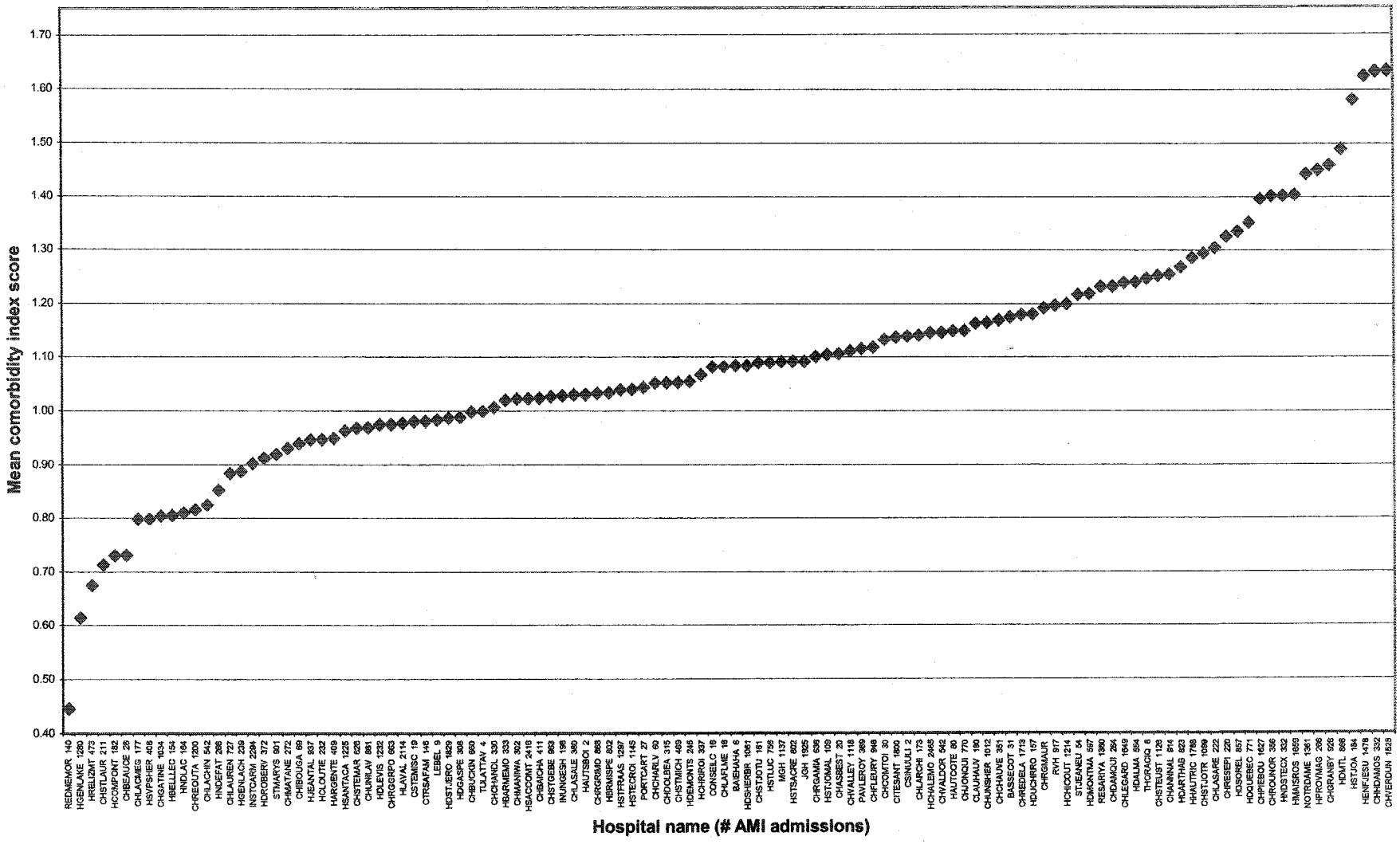


Figure 4-7: Mean comorbidity index score of AMI patients by hospital, sorted by volume of index AMI admissions
Quebec acute care hospitals 1992-1999

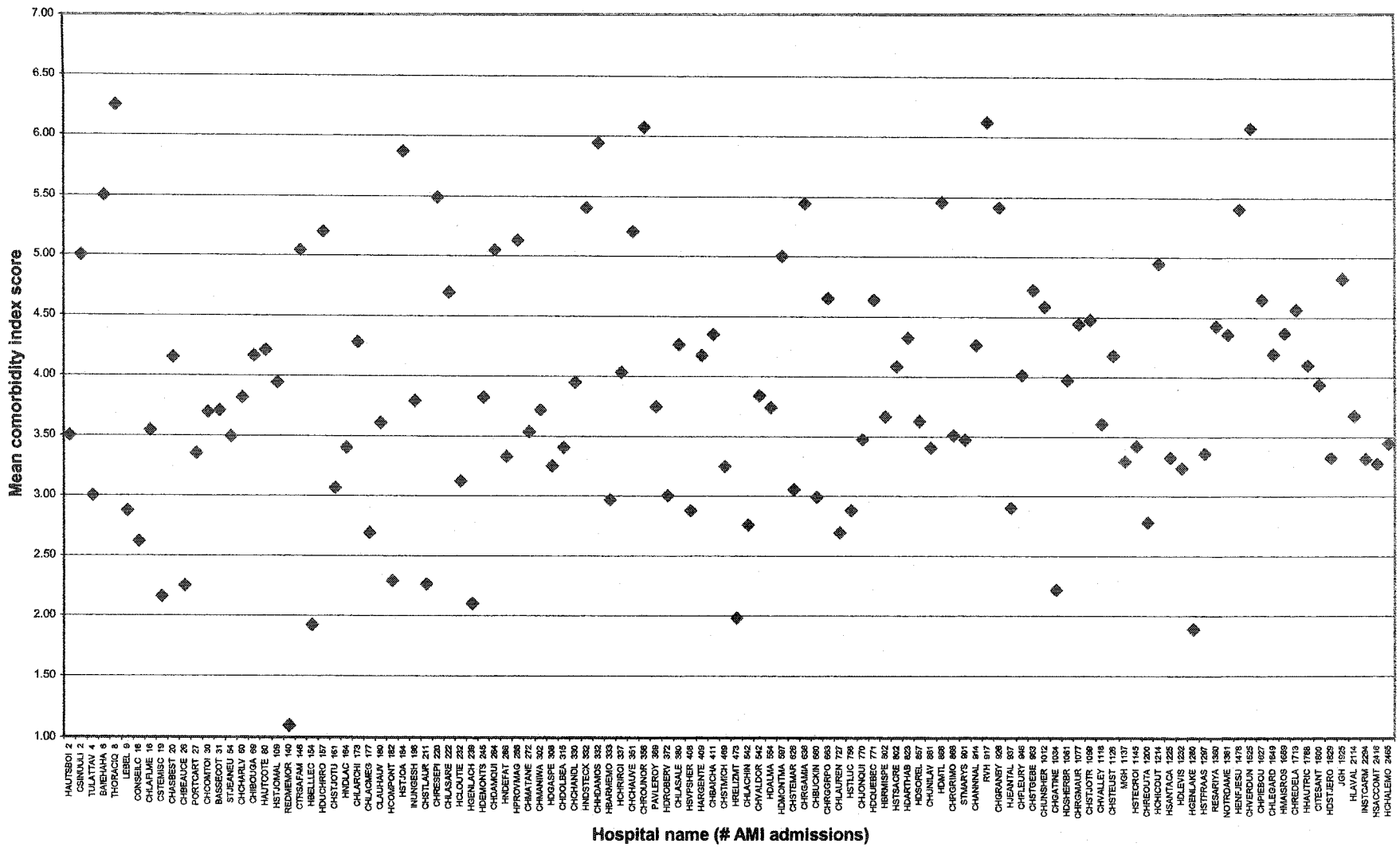


Figure 4-8: Mean prevalence of low SES in AMI patients' area of residence by hospital
Quebec acute care hospitals 1992-1999

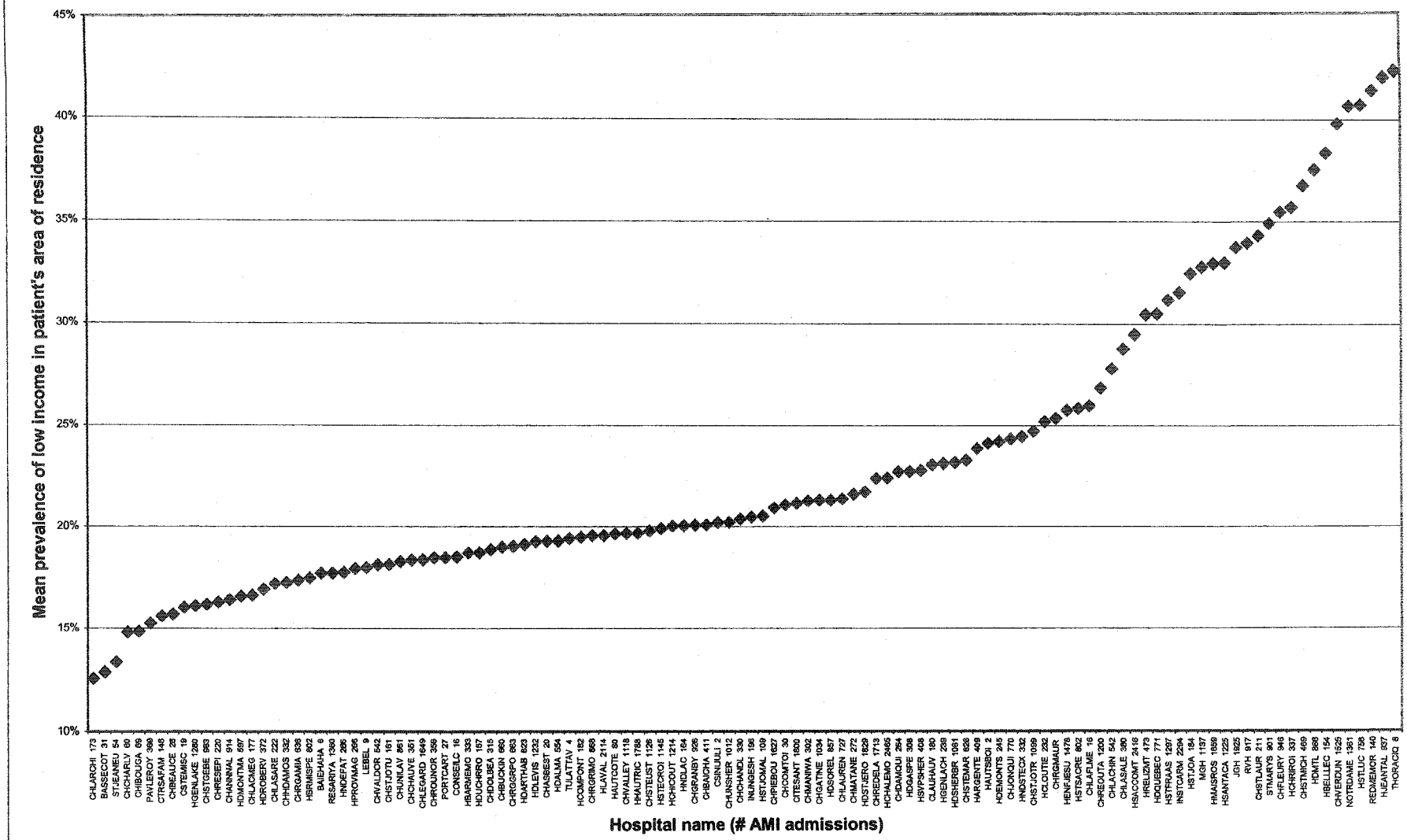


Figure 4-9: Mean distance to tertiary care centre for AMI patients by hospital
Quebec acute care hospitals 1992-1999

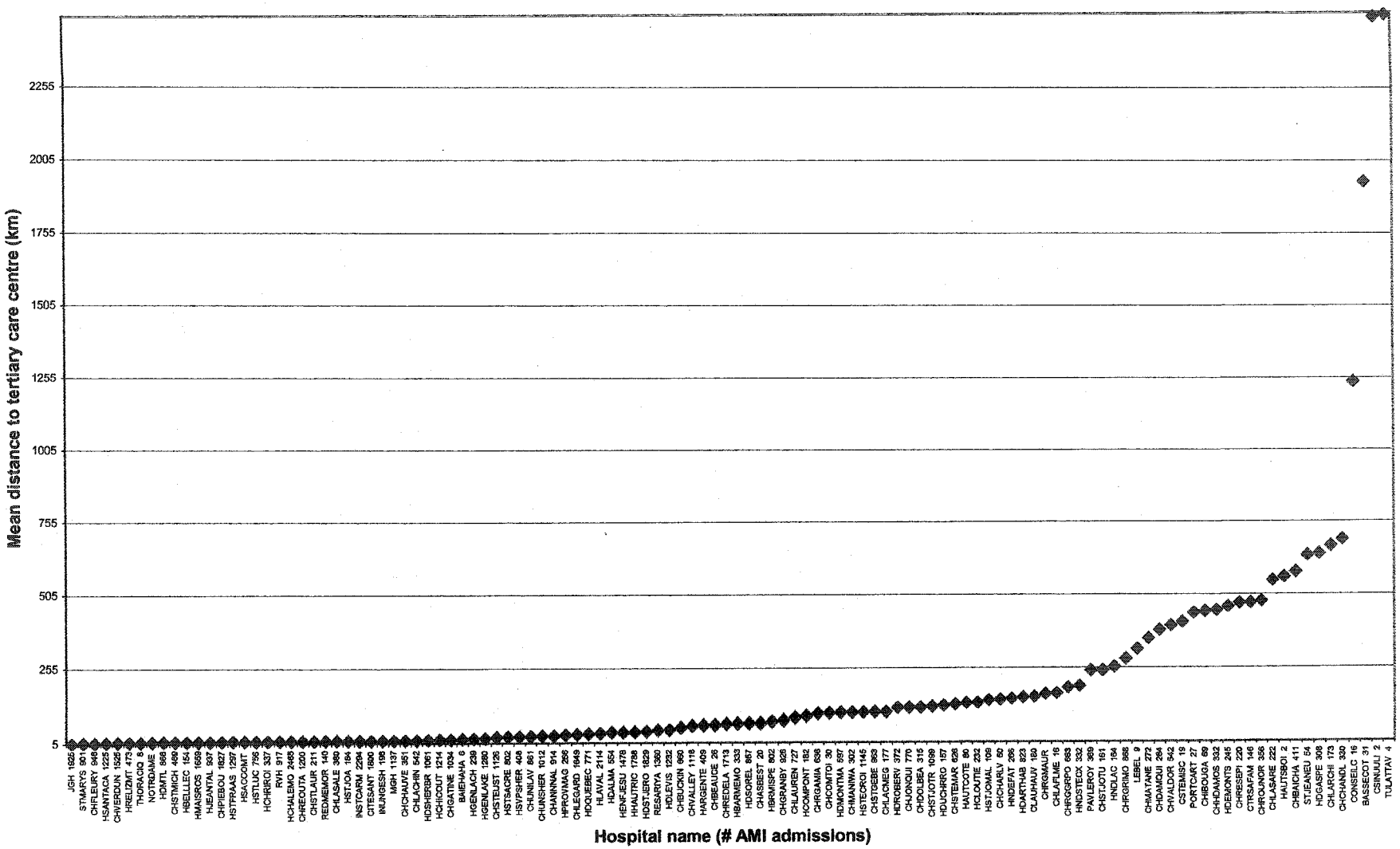


Figure 4-10: Mean distance to tertiary care centre for AMI patients by hospital truncated at 700 km (4 hospitals removed) and figure re-scaled
Quebec acute care hospitals 1992-1999

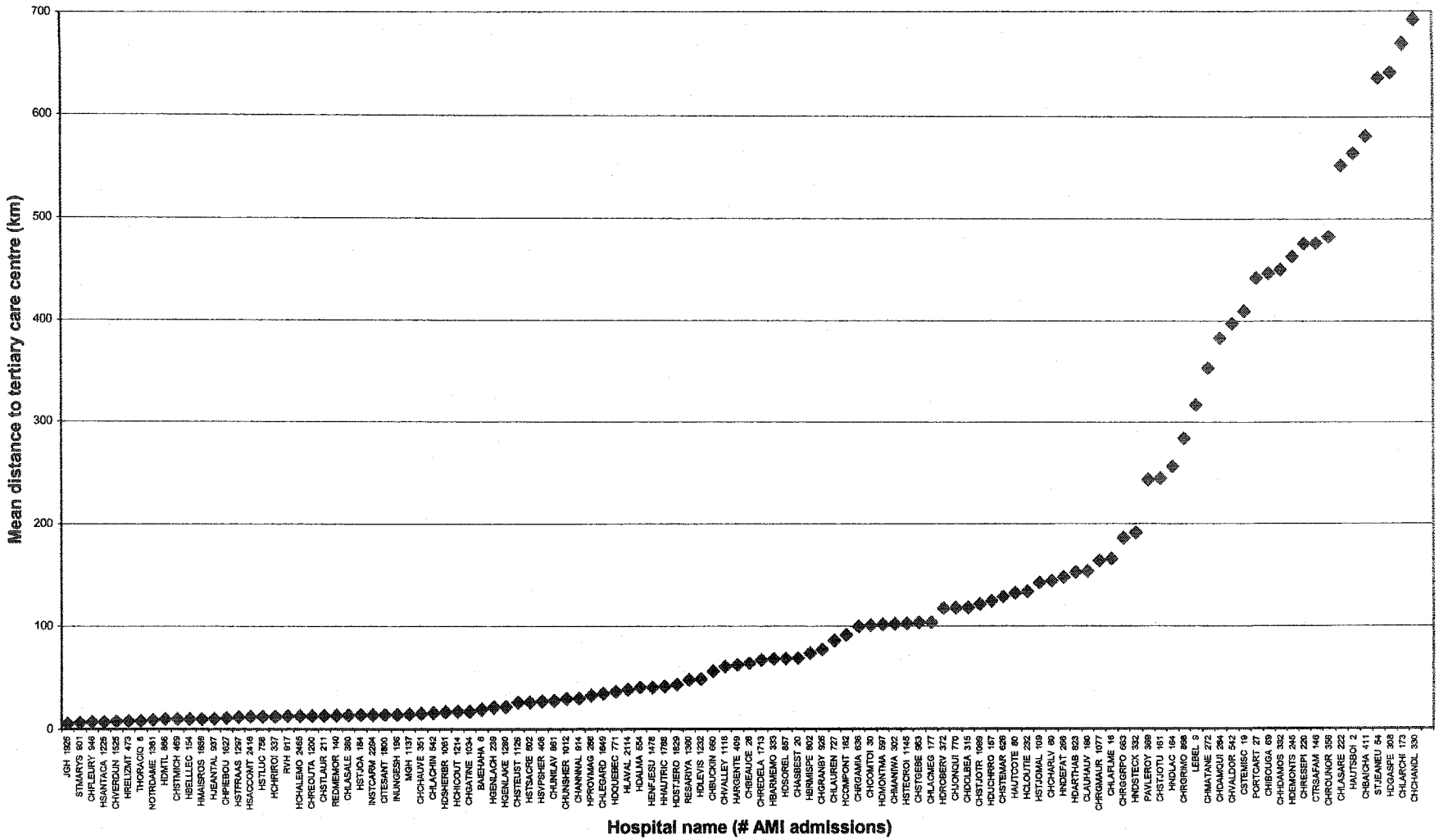
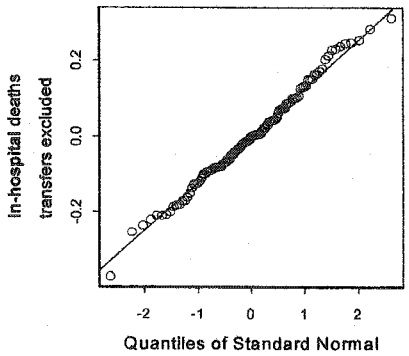
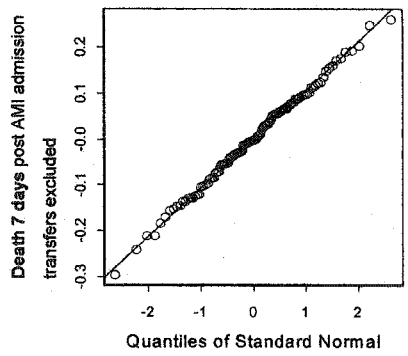
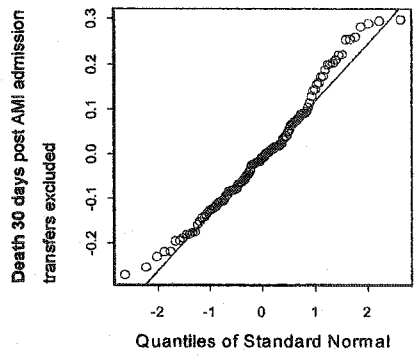


Figure 4-11: Normal probability plots for Empirical Bayes Estimates of Hospital-specific log odds of death
Using 3 analyses that compare outcomes and for 3 analyses that compare how transfers are handled

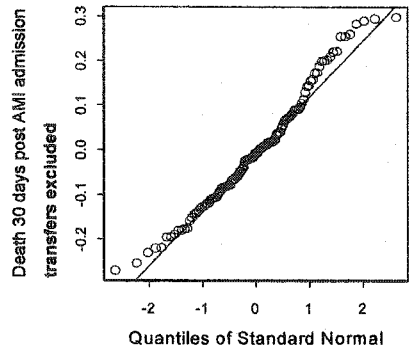
Outcomes

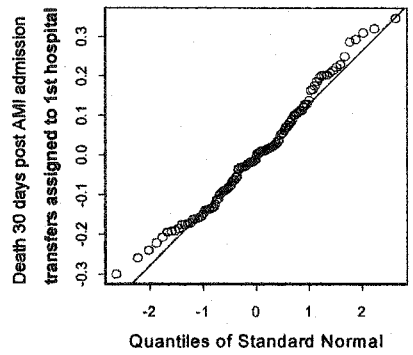






Dealing with Transfers





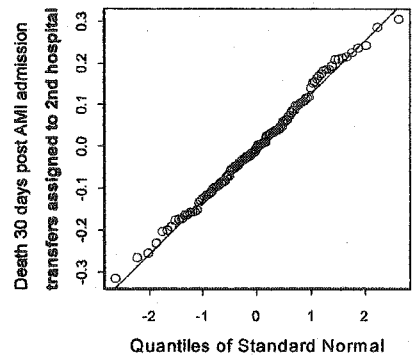


Figure 4-12: Distribution of Adjusted Death Rates

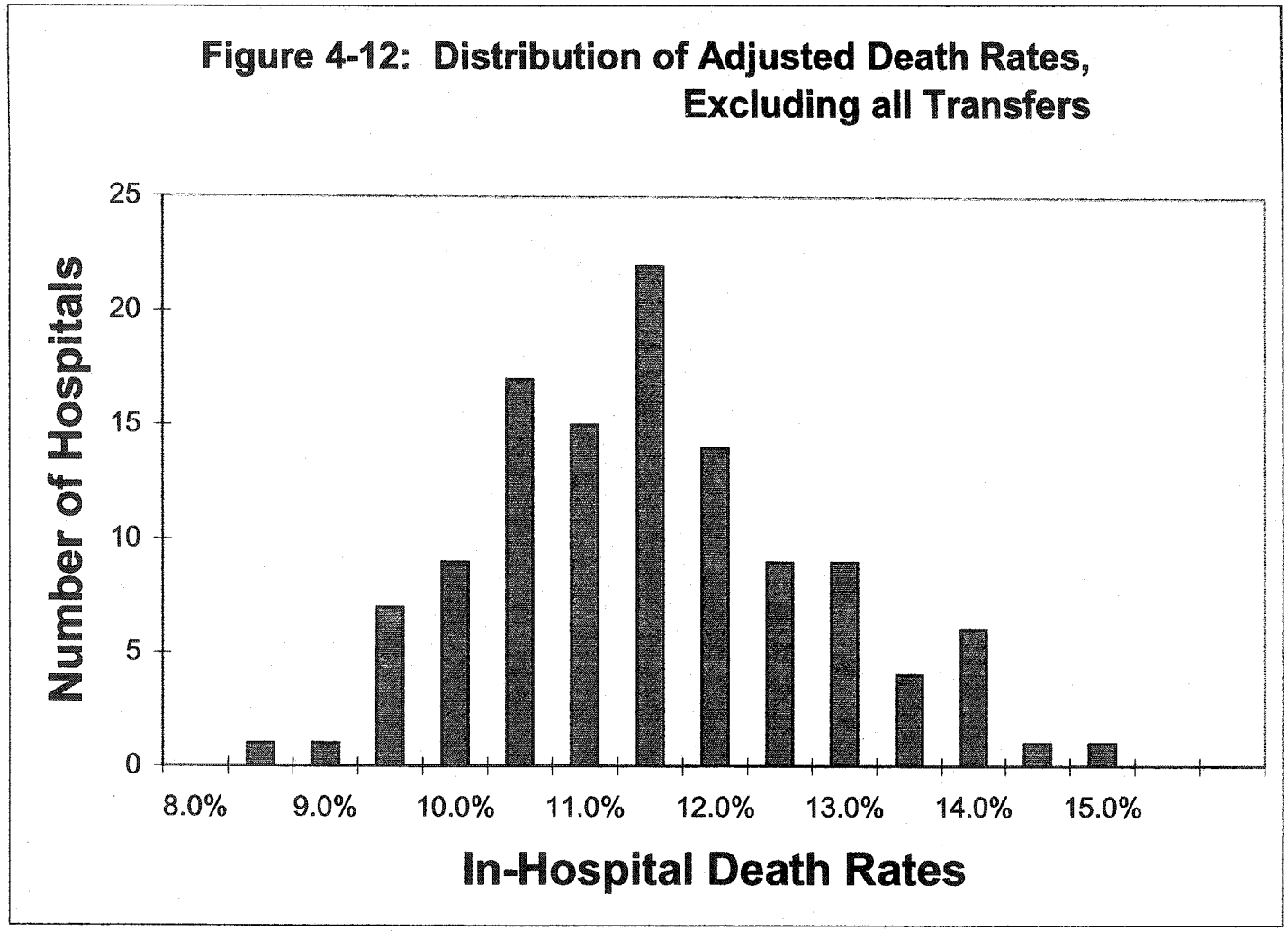


Figure 4-13: Variation in crude death rates across hospitals with no adjustments

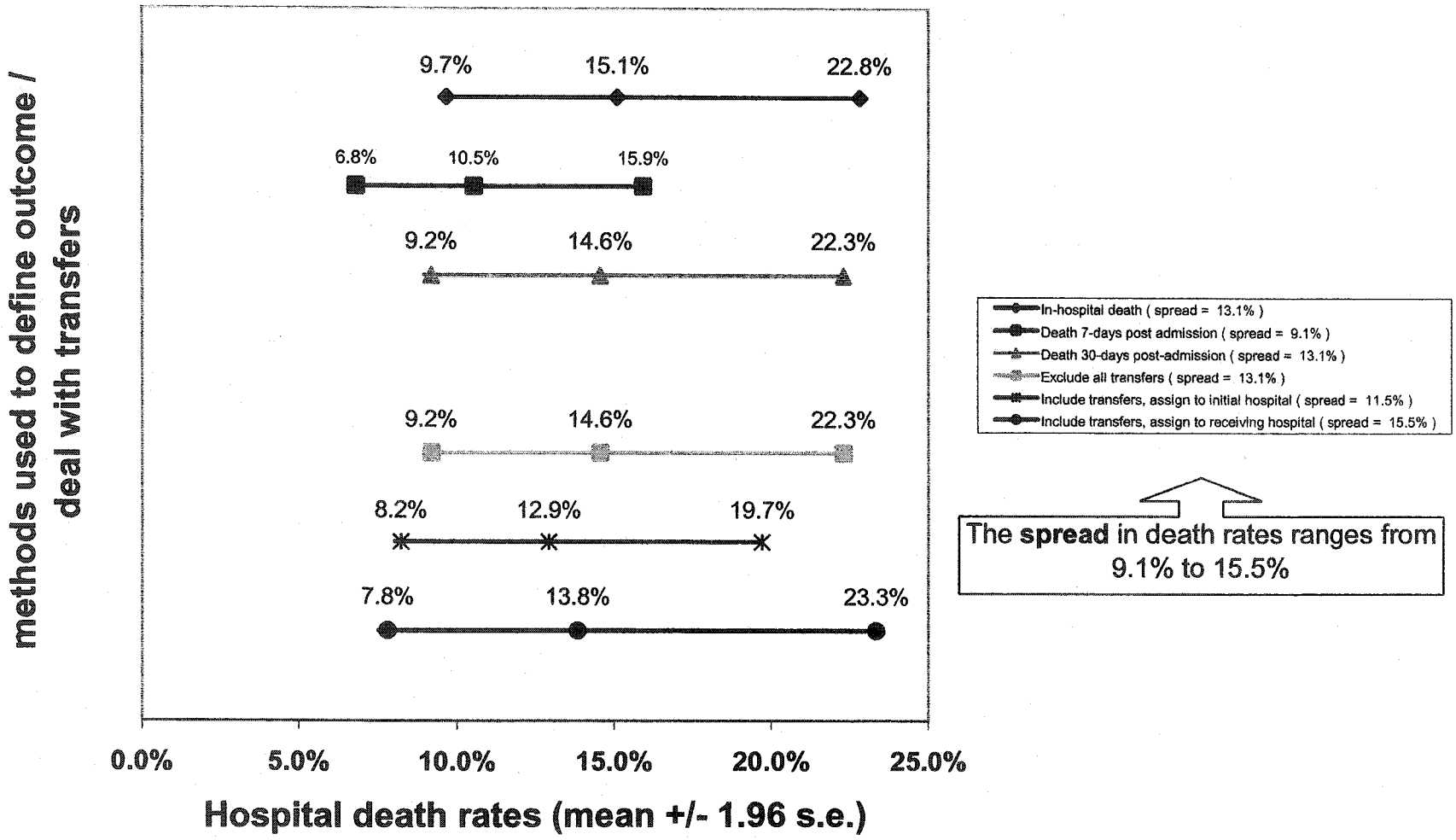


Figure 4-14: Variation in death rates across hospitals adjusting for patient characteristics only

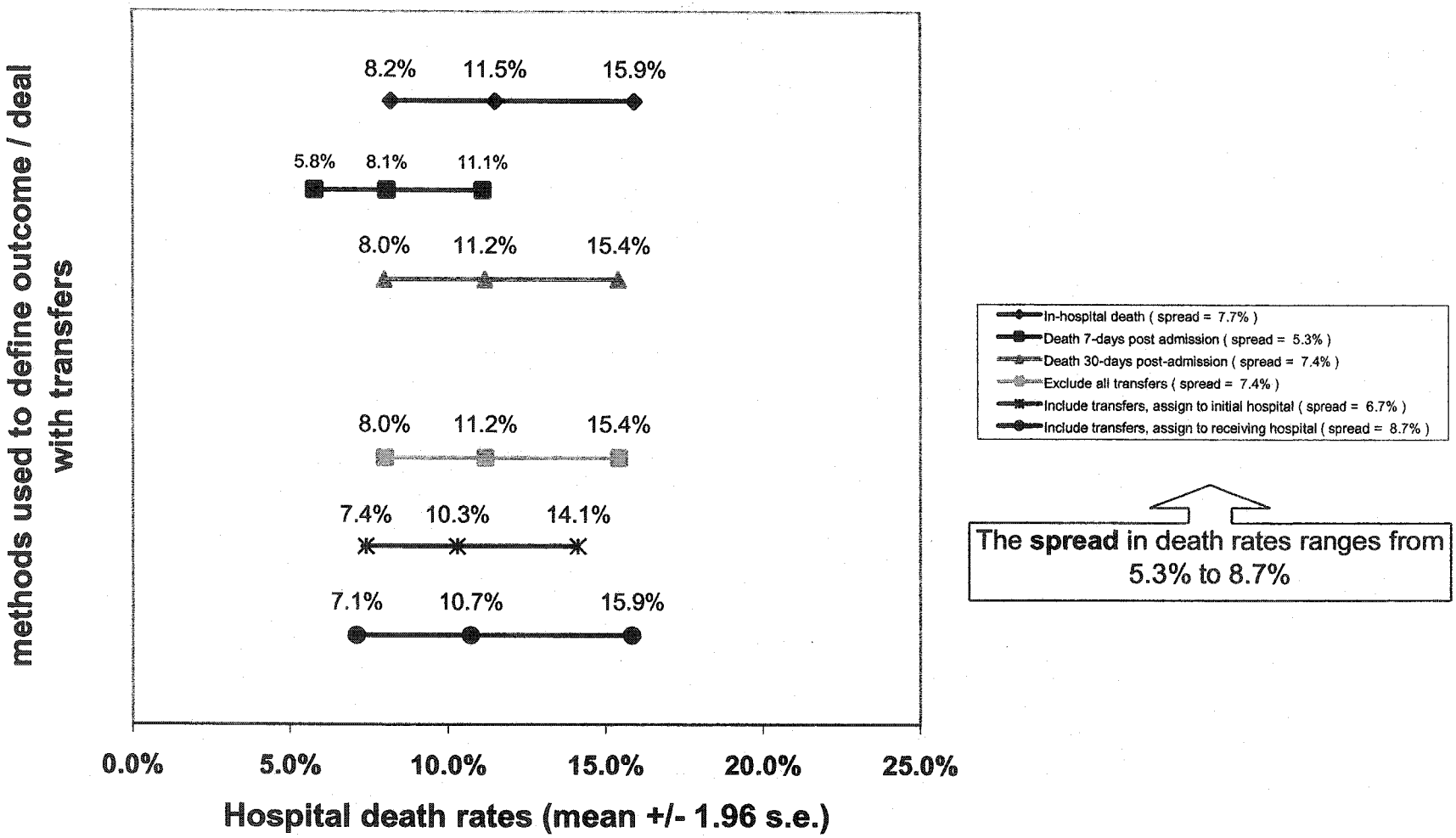
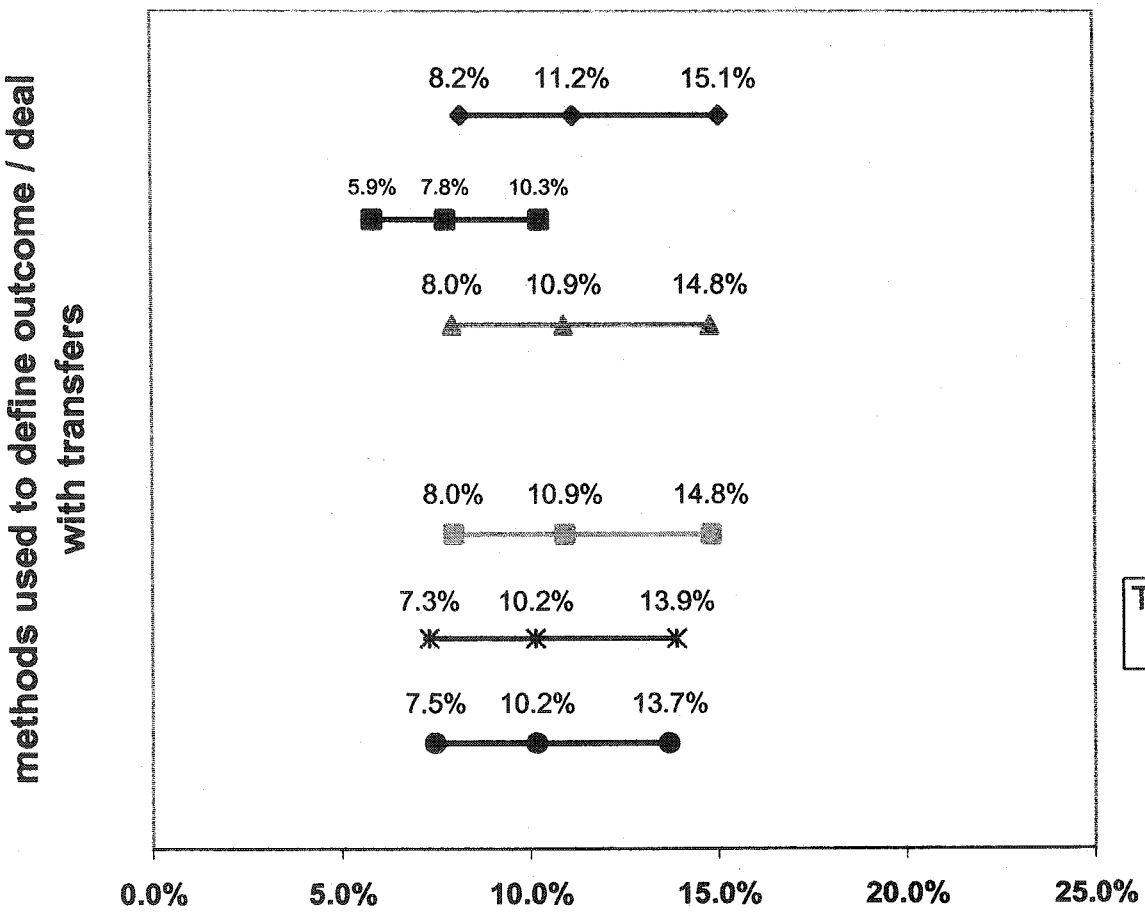


Figure 4-15: Variation in death rates across hospitals adjusting for patient & hospital characteristics



In-hospital death (spread = 6.9%)
Death 7-days post admission (spread = 4.4%)
Death 30-days post-admission (spread = 6.8%)
Exclude all transfers (spread = 6.8%)
Include transfers, assign to initial hospital (spread = 6.6%)
Include transfers, assign to receiving hospital (spread = 6.2%)

The **spread** in death rates ranges from 4.4% to 6.9%

Figure 4-16: Death rates using 3 different ways to define outcome, transferred patients excluded from all 3 analyses

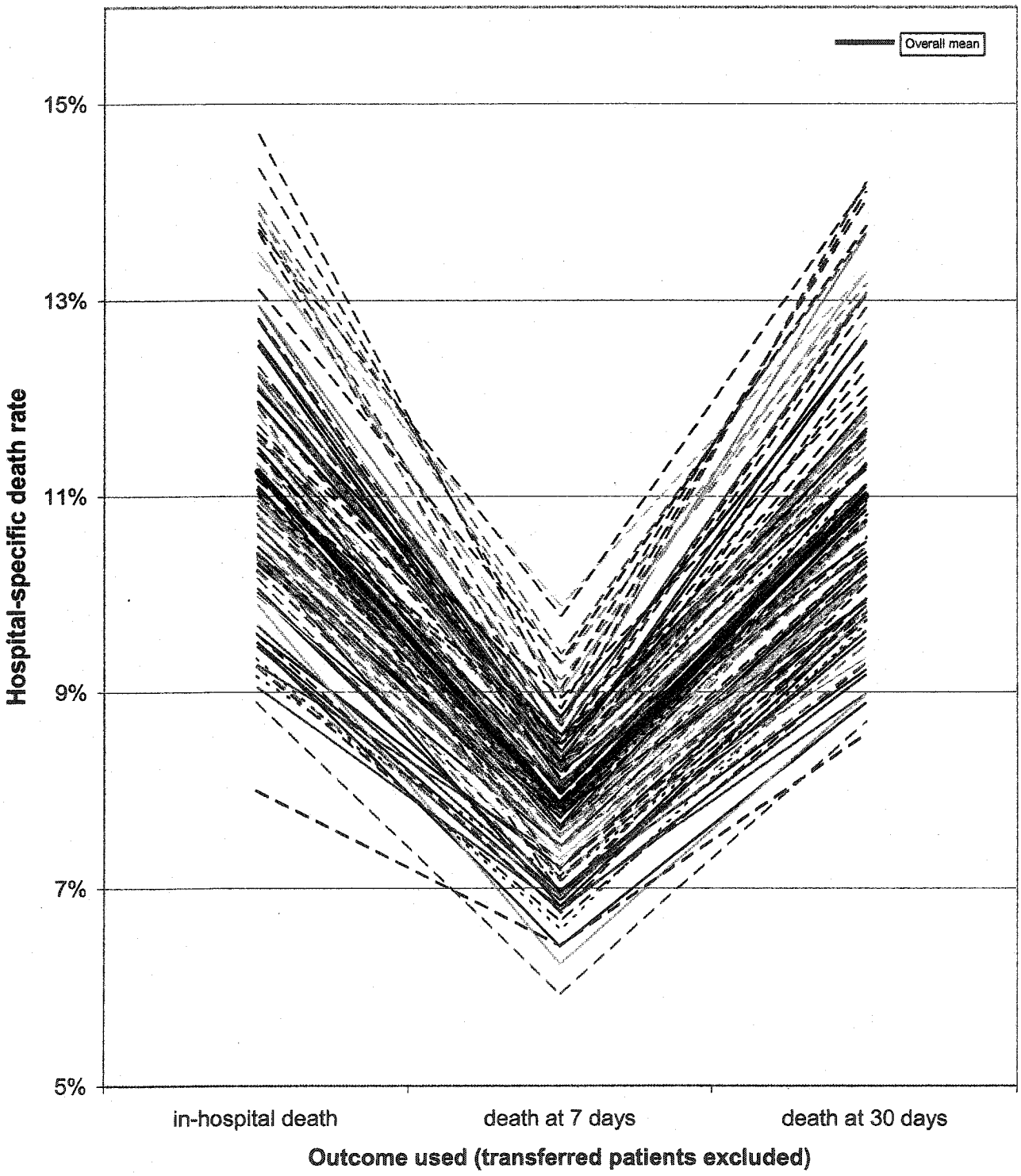


Figure 4-17: Death rates using 3 different ways to handle transfers, death at 30 days used as outcome in all 3 analyses

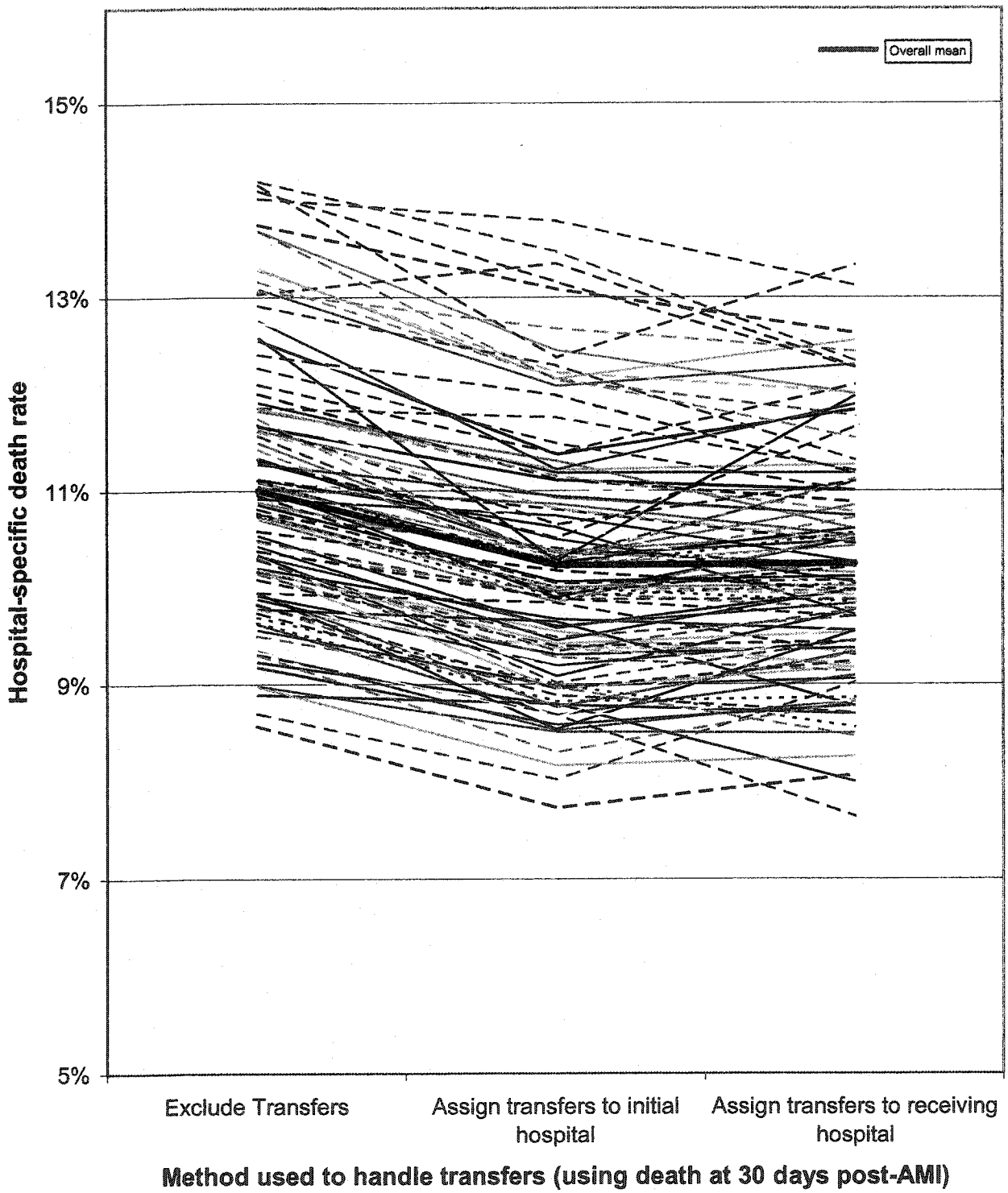


Figure 4-18: Death rates using 2 different ways to define outcome, transferred patients excluded from both analyses (by type of hospital)

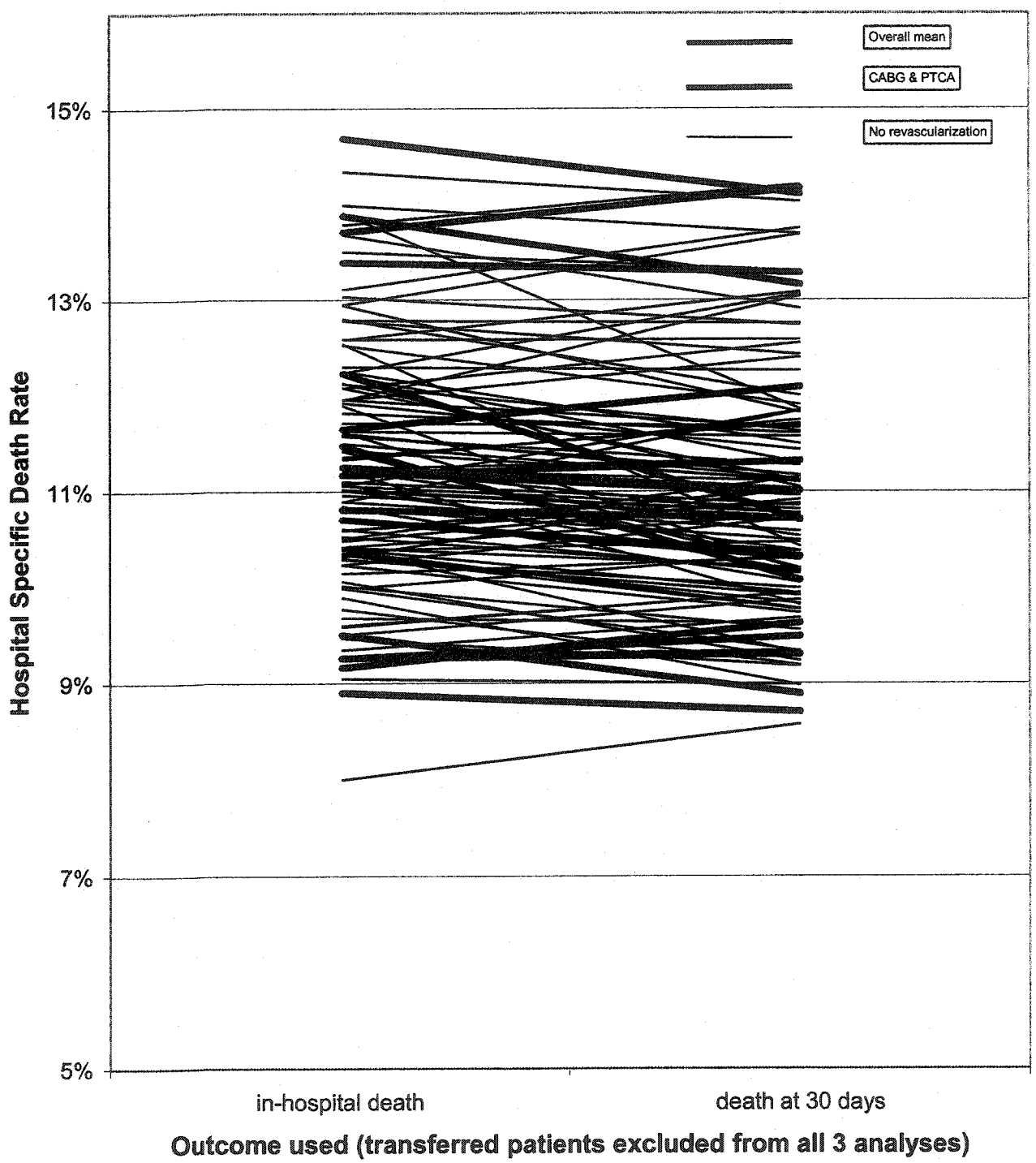


Figure 4-19: Death rates using 3 different ways to handle transfers, death at 30 days used as outcome in all 3 analyses (by type of hospital)

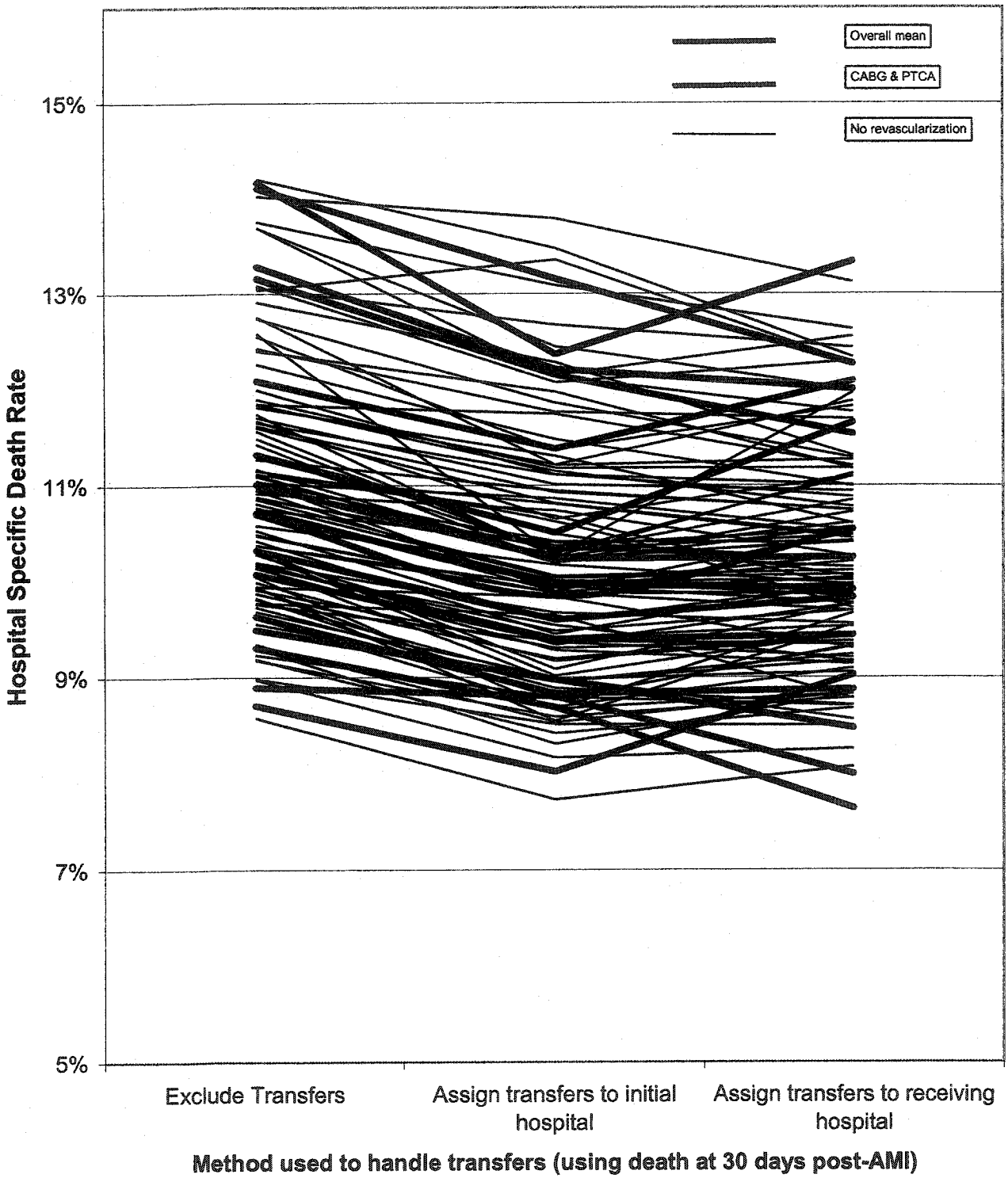


Figure 4-20: Hospital-specific adjusted death rates

Transfers Excluded

Definition of outcome: **In-hospital death**

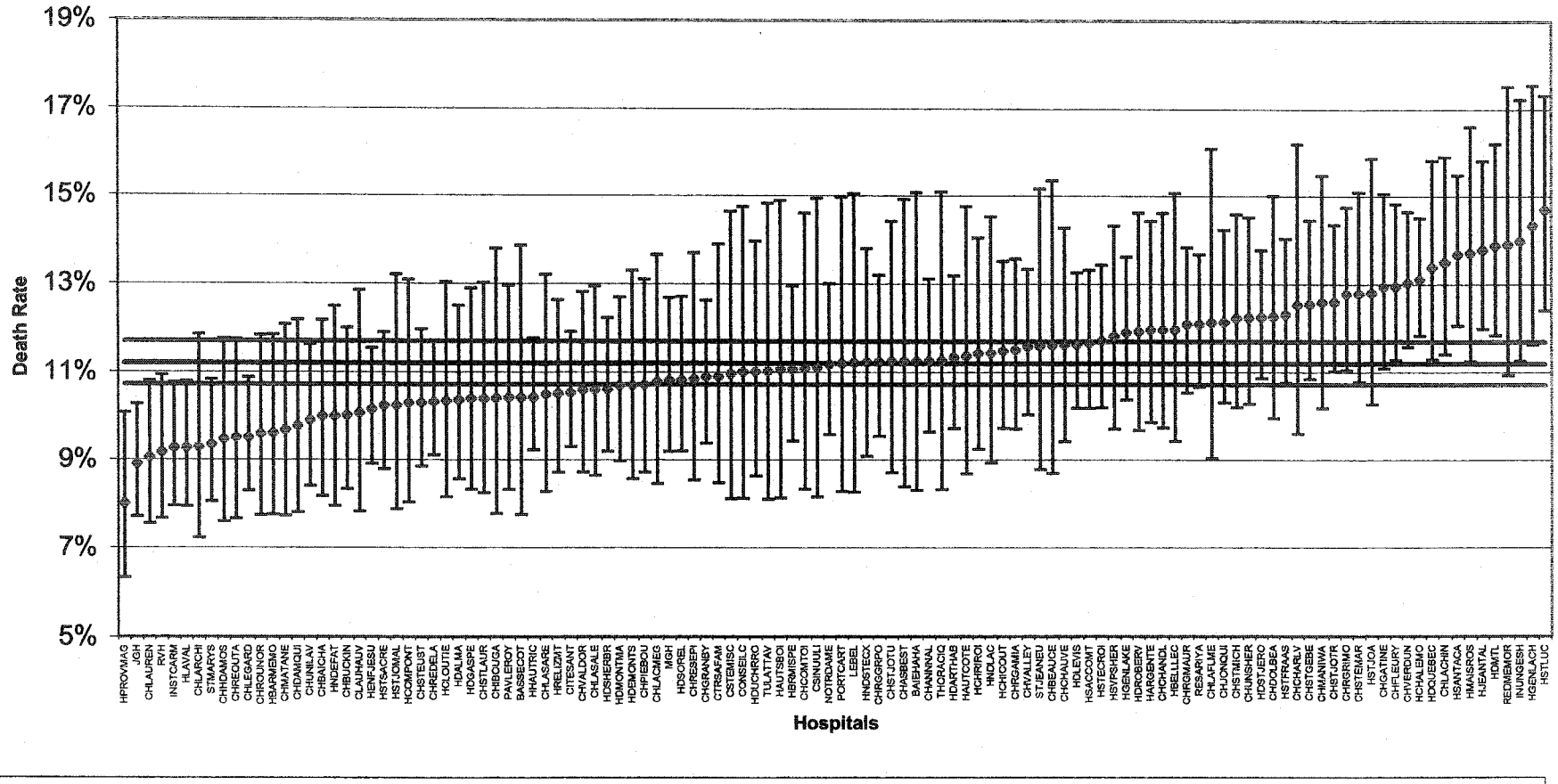


Figure 4-21: Hospital-specific adjusted death rates

Transfers Excluded

Definition of outcome: **Death at 7 days post AMI admission**

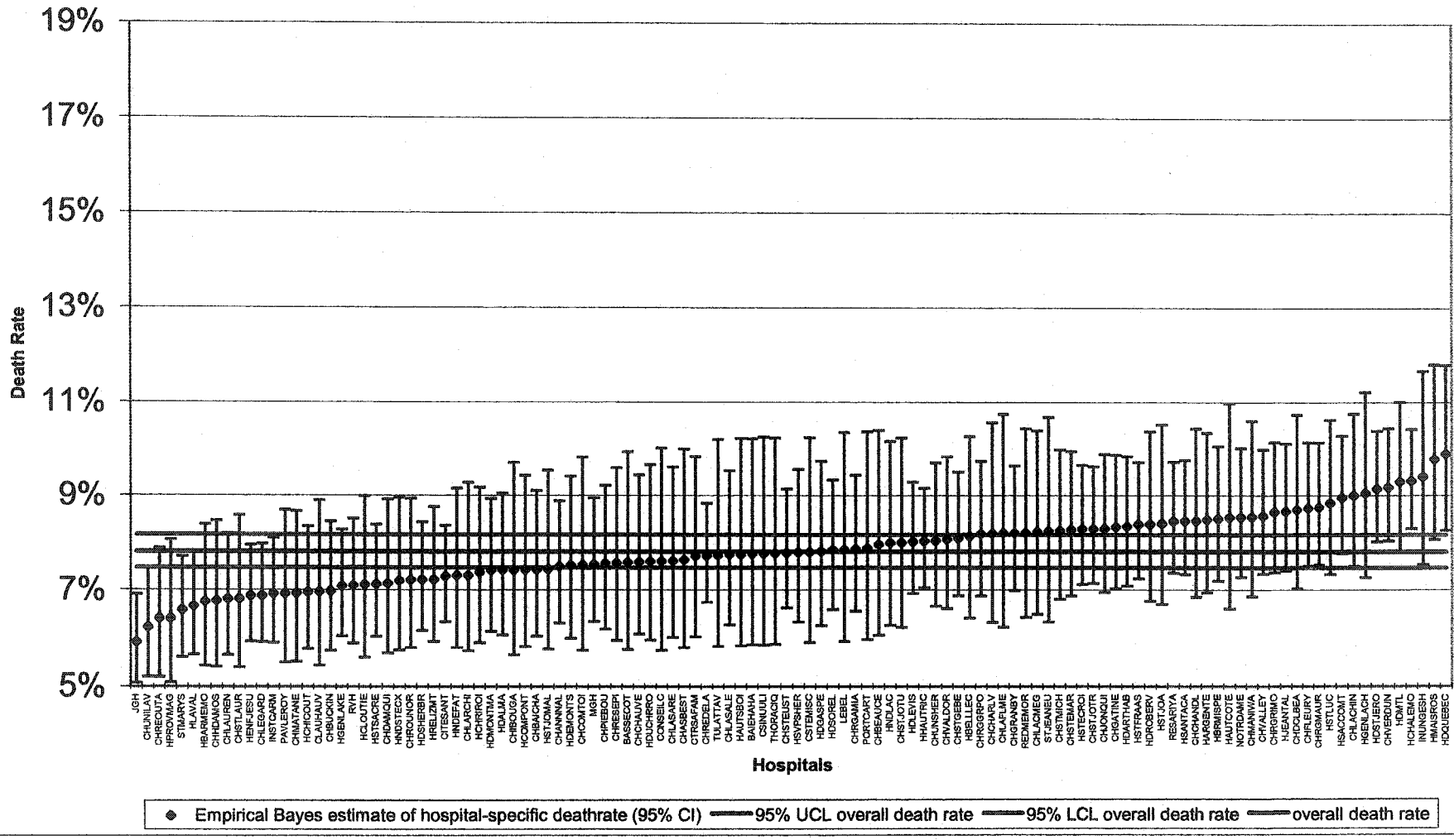


Figure 4-22: Hospital-specific adjusted death rates

Transfers Excluded

Definition of outcome: **Death at 30 days post AMI admission**

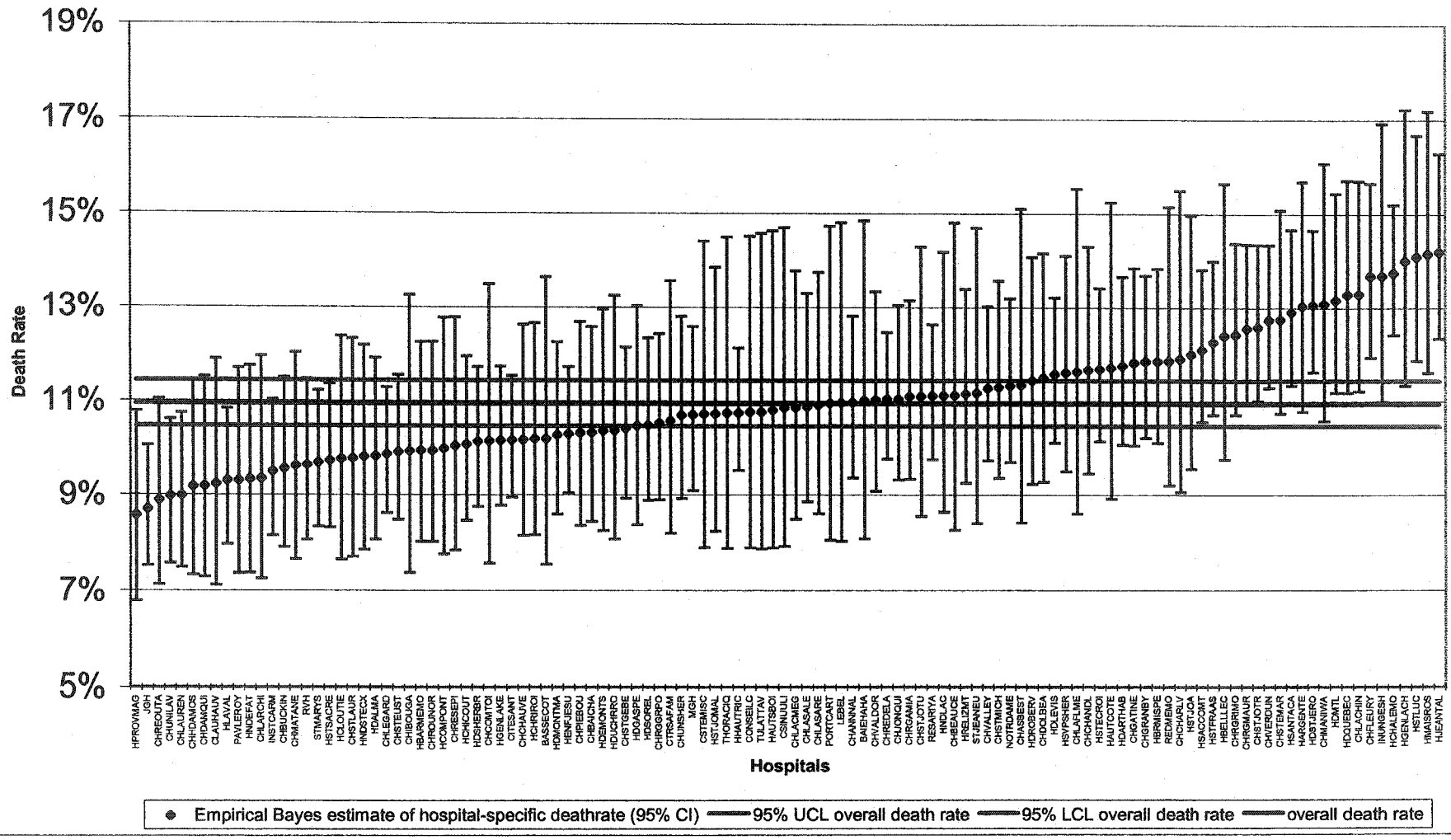


Figure 4-23: Hospital-specific adjusted death rates
Death at 30 days post AMI admission
Method used to handle transfers: **Transfers excluded**

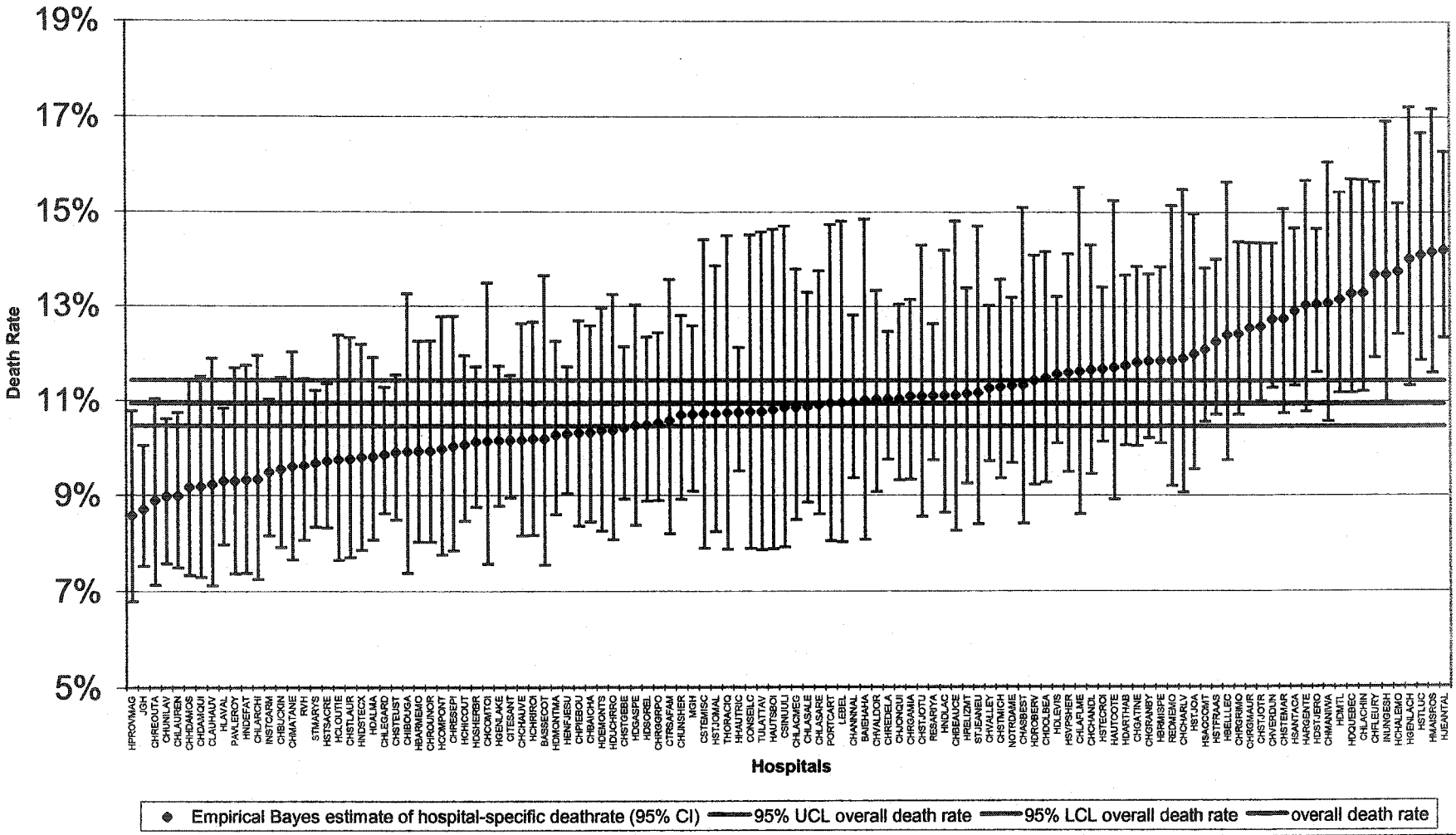


Figure 4-24: Hospital-specific adjusted death rates

Death at 30 days post AMI admission

Method used to handle transfers: **Transfers included, assigned to initial hospital**

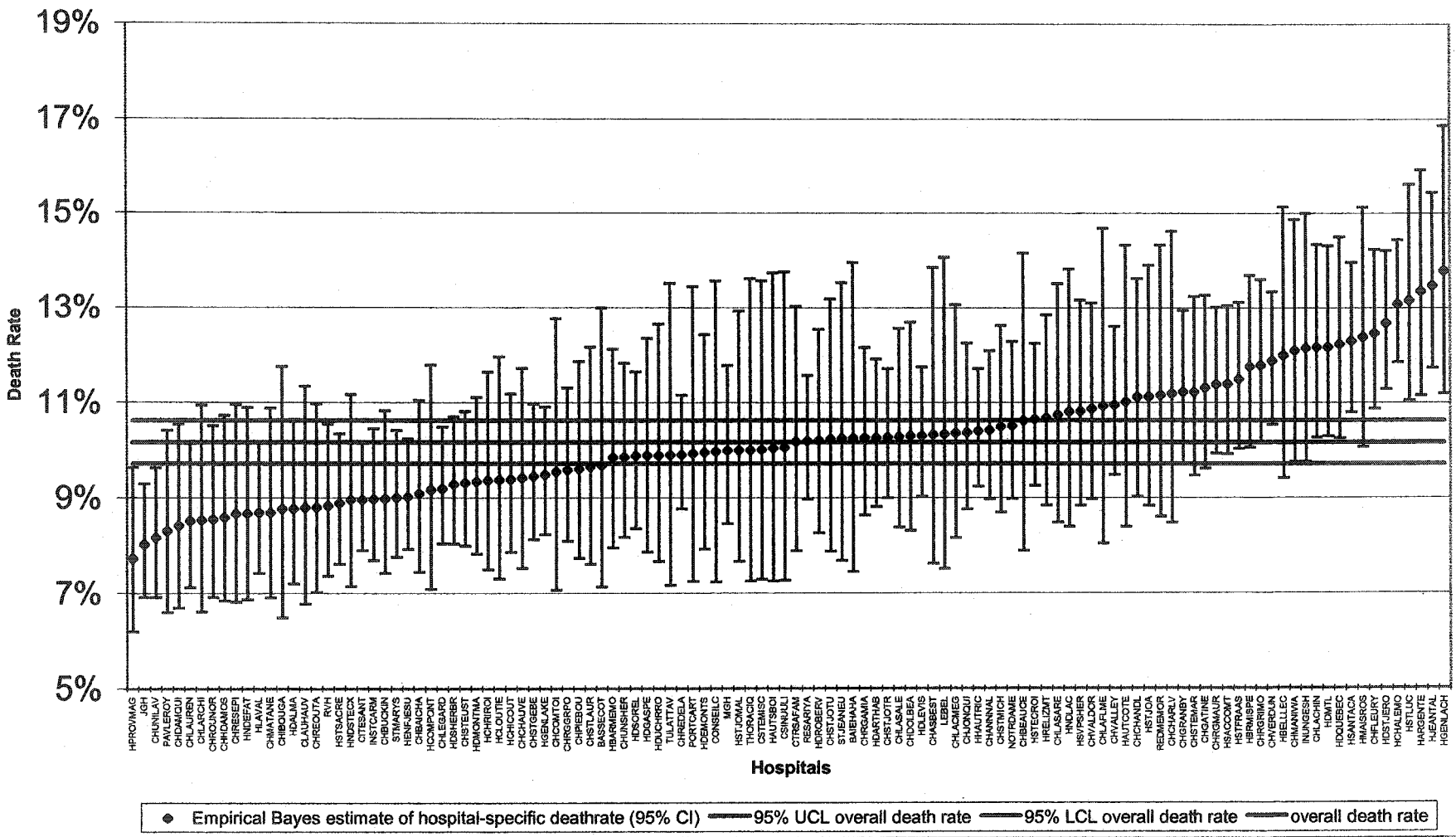


Figure 4-25: Hospital-specific adjusted death rates

Death at 30 days post AMI admission

Method used to handle transfers: **Transfers included, assigned to receiving hospital**

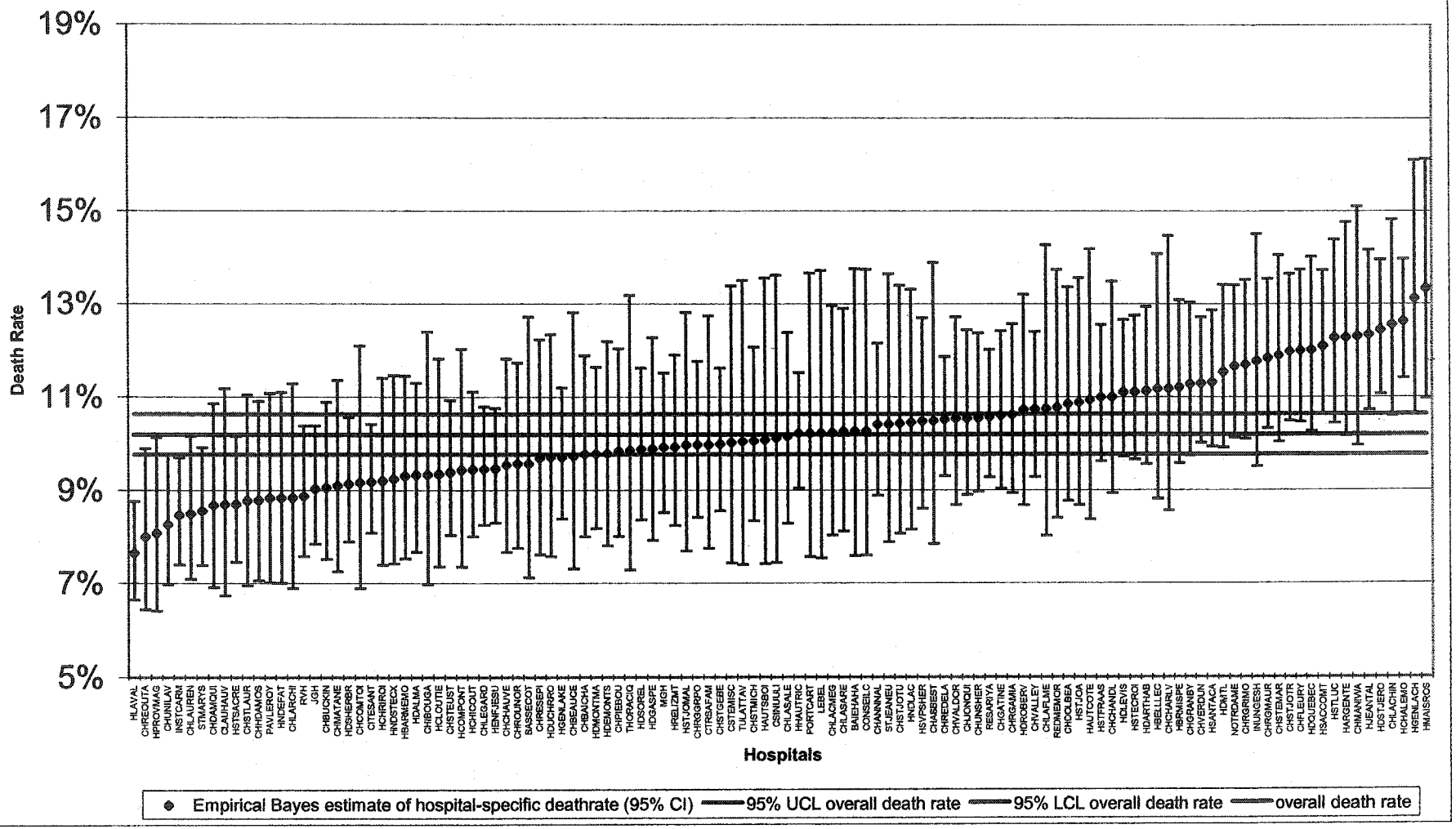


Figure 4-26: Distribution of differences between hospital specific and overall mortality rates

Figure 4-26a: **Transfers Excluded In-hospital Deaths**

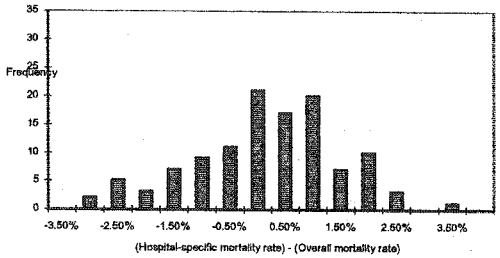


Figure 4-26b: **Transfers Excluded Deaths at 7 days post-AMI admission**

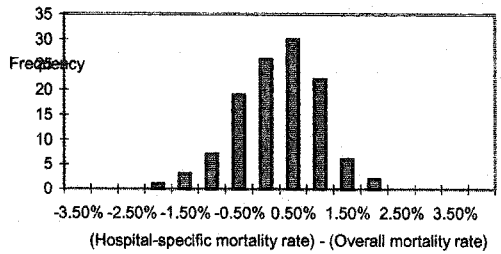


Figure 4-26c: **Transfers Excluded Death at 30 days post-AMI admission**

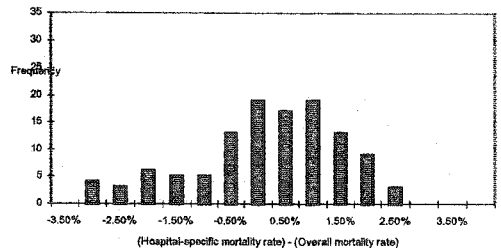


Figure 4-26d: **Transfers Excluded Death at 30 days post-AMI admission**

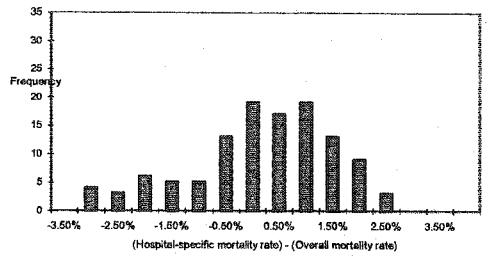


Figure 4-26e: **Transfers included Death at 30 days post-AMI admission assigned to INITIAL hospital**

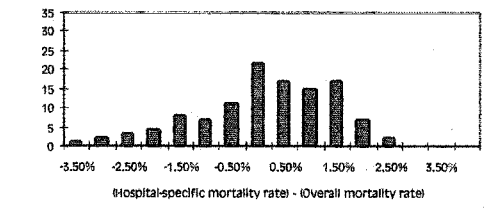
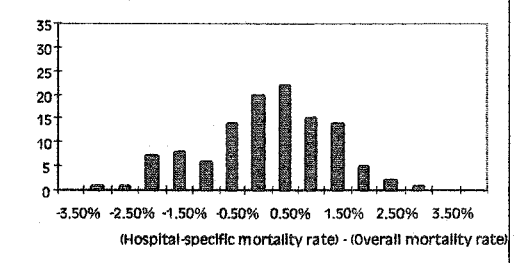


Figure 4-26f: **Transfers included Death at 30 days post-AMI admission assigned to RECEIVING hospital**



Chapter 5 DISCUSSION

Principal Findings

This study has found that there is more variation in AMI mortality rates among Quebec acute care hospitals than would be expected by chance alone, even after adjusting for patient and hospital characteristics. The extent to which methods used to define outcomes or to handle transfers impact on hospital performance ratings depends upon the perspective with which these results are interpreted.

From the perspective of the health system, the methods used to define the mortality outcome or to deal with transfers had little impact on the overall hospital mortality rate (10% to 11%) or on the spread (up to 7%) in hospital mortality rates, with one exception. When using 7-day post-AMI admission mortality outcome, the overall mortality rate (8%) and the spread (less than 4%) were both reduced compared to all other models.

From the perspective of individual hospitals, the outcome definitions used (in-hospital deaths, death at 7 days and at 30 days post AMI admission) and the methods used to deal with transfers (transfers excluded, transfers included but assigned to 1^{st} or 2^{nd} hospital) did have an impact on hospital performance rankings when comparing AMI patient mortality rates.

Also of particular interest, are the differences found in attributes between patients who are transferred and those who are not. This study found that transferred patients were younger, had fewer comorbidities and were less likely to die within 30 days of admission than non-transferred patients.

Importance of findings

A health system perspective

Variation in mortality rates between hospitals was examined in a series of analyses that were illustrated in Figure 4-15. When comparing the three methods used to define the timeframe for outcome evaluation, the average hospital-specific AMI mortality rate was lowest when measured at 7-days post AMI admission (7.8%) than when measured in-hospital (11.2%) or at 30-days post AMI (11%). This 7-day post AMI admission time frame for outcome evaluation also resulted in the least inter-hospital spread in mortality rates (3.8% spread, ranging from 5.9% to 9.9%).

These findings suggest that the outcome selected for study may in fact represent different processes of care. For example, it is possible that the 7-day hospital mortality rates may be more representative of outcomes related to the delivery of evidence-based medical practice. Specifically, the 7 to 10 day period following an AMI has been used as a timeframe during which the efficacy of medical intervention in reducing mortality outcomes is evaluated (232). The types of medical interventions referred to here may include the administration of thrombolytic agents or the timely decision to perform invasive revascularization procedures for patients who require these. Mortality outcomes beyond this timeframe may, on the other hand, reflect the effectiveness of the coordination and organization of care offered by the hospital (233). In the case of AMI patients this type of care may include nursing care, discharge planning, coordination of services during the hospital admission, liaison with professionals designated to provide follow up care and education regarding cardiovascular risk factors, or rehabilitation after discharge.

From the perspective of a public health policy maker, the results suggest that, if best medical practices were to be uniformly applied across all

hospitals, it should be possible for all hospitals to reduce their mortality rates to the level of the "best performer". Hence, when considering the implementation of best practices for medical interventions during the first 7 to 10 days post-AMI admission, it should be possible to achieve an overall adjusted 7-day post-AMI mortality rate of 5.9%, rather than the current adjusted rate of 7.8%. In a population of 78,113 AMI patients (where transfers are excluded), this reduced mortality rate would represent a 1.9% difference in mortality rate, or 1,484 fewer deaths. At the level of the health system, processes of care would need to be evaluated in order to identify possible system deficiencies and resources would be required to make the required changes. These "costs" and resources would need to be considered in light of the potential number of deaths that may be avoidable.

Similarly, the uniform implementation of best practices in terms of the coordination and organization of care could also be considered in order to reduce the overall mortality rate to the level of the "best performer". For example, it should be possible to achieve an overall 30-day post-AMI mortality rate of 8.6%, as compared with the current rate of 11%, a 2.4% difference, which in a population of 78,113 AMI patients (where transfers are excluded) would correspond to 1,875 fewer deaths. Once again, health system processes would need to be evaluated and associated "costs" and resources for implementing required changes would need to be considered in light of the potential number of deaths that may be avoidable.

A hospital administrator's perspective

The implications of these findings are different for hospital administrators. In this case, the methodology had a substantial impact on the hospital ranks.

The study results indicated that there was discordance in quintile classification for 34% to 43% of hospitals when pairwise comparisons were conducted between outcome definitions. There was also discordance in quintile classification for 23% to 32% of hospitals when pairwise comparisons were conducted between different ways of handling transfers. Hospital ranks changed up to 3 quintiles in pairwise comparisons. This magnitude of change in the quintile classification of a hospital rank would have a substantial impact on the efforts of a hospital administrator who is attempting to support a fundraising campaign, or who needs to re-assure patients being treated in that particular hospital.

Similar points can be raised when gauging the shift of hospitals across deciles as a way to determine the impact of various study methods on hospital rankings. While health care analysts and policy makers might monitor the performance of the system as a whole (looking at all hospitals at one time), hospital administrators might be more interested in knowing whether they are the leaders in the pack, or the worst of the lot. Similarly, hospital administrators and policy makers alike might be interested in identifying hospitals that "stand out" either to instil widespread use of practices that lead to best outcomes or to eliminate practices that lead to undesirable outcomes. This study found that hospital mortality ranks were not consistently situated in the highest or lowest deciles for several hospitals, indicating that the methods used to define outcomes or to handle transfers can have a considerable impact on hospital performance decile ratings.

Hospital ranks that are used to identify the best and worst performers are not only relevant to hospital administrators but may be the most meaningful way to present comparison reports to the general public. Even though patients may not have a choice regarding what hospital to be taken to in the case of an emergency, such as an AMI, hospital rankings that identify outliers can lead to widespread concerns regarding the inequities in health care delivery within a jurisdiction, such as the Province of Quebec.

Regarding transferred patients

The differences found between transferred and non-transferred patients in this study may also be indicative of sound clinical practice whereby transfers are more often carried out for stable patients who have a better chance of surviving the risks inherent in transfers (234), which may in turn explain why this study found better mortality outcomes among transferred patients as compared to non-transferred patients, whereas other studies have reported less favourable results for transferred patients (145). It may be that the jurisdiction in which a study was conducted may be related to the outcomes of transferred patients. For example, in health care systems where hospitals receive payment according to the level of care required by patients and according to the level of performance (including the hospital's mortality rate compared to that of its peers), there may be incentives to transfer more seriously ill patients to other facilities in a possible effort to generate desirable performance results. Therefore, given this study's findings are inconsistent with previous reports, these inconsistencies merit further investigation in the context of measuring the quality of health care services.

A somewhat concerning finding is that females made up 36% of AMI patients discharged from the initial hospital without being transferred, but

they accounted for only 28% of AMI patients transferred to another hospital. Although female patients were older than male patients in this study, which may explain the higher crude odds ratio of death among female versus male patients being approximately 2:1 (corresponding to a slope of 0.7 in the logit scale) (Table 4-6), the adjusted odds ratio of death for females compared to males was 1.2 (corresponding to a slope of 0.23 in the logit scale) (Table 4-9). If timely transfers do indeed result in saving lives, the gender disparity in patient transfers following AMI admissions may warrant further investigation. Some factors underlying this disparity that may merit being explored include gender differences in: pre-hospital care, in treatment practices, and in delays between symptom onset and arrival to hospital (153;235).

These differences in characteristics between transferred and non-transferred patients may have led researchers to exclude these patients from AMI hospital mortality studies in the past (5;88;91;107;203). However, these findings may also underscore the importance of understanding the impact of excluding transferred patients from such studies. Excluding a sub-population of AMI patients from performance studies may have a more severe impact on findings than simply limiting the generalizability of results. While on the one hand such studies can be said to apply to a more restrictive population of AMI patients, it should be noted that the construct of interest is hospital performance, and not AMI patient mortality per se. From this perspective, excluding transferred patients may jeopardize the internal validity of comparative hospital performance studies.

Comparability to other AMI populations and hospital performance studies

Before judging a hospital's performance, it is important to take into account patient and hospital factors that may explain differences in patient mortality outcomes among hospitals. The average age of patients included in this study was 66 years, and 35% of these patients were female. Nearly half (45%) of the patients did not have comorbidities during their index AMI admissions while 28% and 14% had 1 and 2 comorbidities respectively. While these attributes did not differ among patients admitted to the four (4) types of hospitals depicted in Table 4-3 (based on AMI volume and availability of revascularization facilities), there were significant differences in these patient characteristics across individual hospitals. Patient attributes that did vary across individual hospitals and groups of hospitals, were the proportion of neighbourhood population with household incomes below LICO (low income cut off), as a proxy for socioeconomic status, and distance to the nearest tertiary care centre. Interestingly, these factors are not typically included in hospital performance studies. Generally, hospitals with revascularization facilities admitted new AMI patients of lower income than did other types of hospitals. This discrepancy is not surprising, since tertiary cardiac care hospitals are usually centrally located in large urban areas, where low income intensity is also greatest (236).

This study compares two approaches where inconsistencies have been found in methods used to compare hospital performance levels that have not yet been reported in the literature for the AMI population (time frame used for outcome evaluation and method used to deal with transfers).

Two previous studies have investigated the impact of the timeframe used for outcome evaluation on hospital profiles. One study found substantial

correlation between in-hospital SMRs (standardized mortality ratios) and 30-day SMRs among patients with congestive heart failure (132). The authors also report, however, that the outlier status changed for 7 out of 30 hospitals (23%) when comparing the results using the two outcome definitions. It should be noted that outlier status was based on an SMR being significantly higher or lower than 1.0 for which an expected mortality rate was estimated using an ordinary logistic regression analysis. This study found that outlier status changed for only 5 out of 116 hospitals (4%) when comparing outcomes defined as in-hospital deaths and death at 30 days post AMI admission. The difference in these findings compared to those found by Rosenthal et al. may be attributable to the different statistical analyses used to obtain the hospital-specific mortality rates, where Rosenthal et al. used ordinary regression estimates and this study used Empirical Bayes shrinkage estimators.

The second study that compared the impact of different timeframes used for outcome evaluation on hospital profiles sought to determine whether varying the case definition of deaths following CABG surgery affected the identification of outliers (131). The authors compared 30-day and 6 month mortality rates in addition to using both all cause mortality and mortality due to peri-operative complications. Although the nature of the outcome definitions used are considerably different from the current study, it is interesting to note that this study also obtained apparently unstable estimates, where 5 out of 43 hospitals (11%) changed their outlier status using ordinary regression methods to calculate and compare SMRs.

Both these studies illustrate how hospital performance evaluations may assign hospital ranks, whereby hospitals are falsely identified as poor performing outliers with higher than expected mortality rates. This may have been the case for one Quebec teaching hospital in particular. Haygroup Consulting, a private consulting firm, conducts annual Canada-

wide studies that compare selected performance indicators across teaching hospitals throughout the country. One Montreal-based hospital had the highest all-cause in-hospital mortality rate across participating hospitals two (2) years in a row (91). Unlike the Haygroup study, this study found that the hospital in question, "MGH", fell consistently within the overall average death rate in all six analyses compared. Interestingly, the "MGH" again fell well within the average range in another study comparing hospital mortality rates among stroke patients (237). These discrepancies may be due to problems inherent to studies that compare all-cause mortality rates, as processes of care differ across diagnostic groupings. For example, outcomes for AMI and stroke patients may depend more heavily on the extent to which care processes are organized and coordinated across facilities and health professionals. By contrast, other diagnostic groups, such as trauma, end-stage cancer and palliative care patients are expected to experience very high mortality rates, regardless of the processes of care adopted by specific hospitals. Therefore, mortality rate comparisons may be more appropriate for evaluating hospital performance levels vis-à-vis specific patient groups.

Strengths and limitations

Hospital performance studies have applied longstanding quality control methods used in industry (238), however, unlike many industry settings, where most inputs and processes can be closely controlled, health care services are faced with a multitude of extraneous factors that can increase variability in performance evaluation studies. In addition, this study uses administrative databases, as do many performance evaluation comparative studies, and the results should be interpreted in light of well-known strengths and weaknesses of this source of data.

Administrative databases are accessible at reasonable costs to researchers, administrators and policy makers, making them an attractive source of data for evaluation studies, particularly for studies that are conducted repeatedly on a yearly basis. These data sources are designed to be comprehensive and resources are assigned to ensuring the accuracy of their content (239). Quebec's hospital discharge administrative database, MedÉcho, contains data elements that are similar to most such data sources. For example, hospital discharge data provide information on patient demographics, secondary diagnoses, medical procedures, and dates of: admission, discharge and medical procedures. In addition, unique identifiers provided the ability to link the hospital discharge database with the vital statistics database, in order to provide accurate data regarding dates of death of patients, regardless of the place of death (hospital or other).

An important limitation of discharge databases, however, is that most do not provide detailed clinical information. For example, information required to accurately determine the AMI severity among admitted patients is not typically included in hospital discharge databases and must be extracted from medical records, at a high cost. It is therefore possible that, by not including these data in this study, differences in the severity of illness among patients in this study remain unaccounted for. On the other hand, pre-hospital emergency care in Quebec is provided by private and non-profit organisations that have protocols in place for determining which hospital a patient should be transported to. Taking the patient's status into account, factors that are taken into consideration when making transportation decisions include: the availability of revascularization facilities among candidate hospitals, the availability of the emergency department to accept new patients at the time of the event, and the distance between the patient and the nearest hospital (240). Having accounted for the distance to the closest tertiary care centre, the

availability of revascularization facilities at specific hospitals, and for other patient-level characteristics such as age, gender, comorbidities and neighbourhood SES level, it is plausible that the combination of all these factors would provide a reasonable proxy measure for the severity of illness among AMI patients.

Given the sources of data used in this study, it was not possible to measure socioeconomic factors other than income, such as level of education, culture of origin and other similar factors. Furthermore, income was included as an ecological variable in this study because the law protects individual information and because annual performance studies do not typically deal with specific information on SES at the individual level. On the other hand, it may be that the SES construct of greatest interest is measured at the neighbourhood level. In other words, the extent to which an individual's neighbourhood offers support, access to resources, a sense of belonging and community may be more important determinants of the outcome of AMI than the individual level of income, which may change suddenly and unpredictably, or the level of education, which may or may not ensure social support and a sense of well-being. It is perhaps the "neighbourhood" component of the SES construct that explains why SES variables used at an aggregate level are associated with AMI mortality at the individual level.

Should these data become accessible while ensuring confidentiality of individuals, this type of information may reduce the residual bias that may remain after accounting for the type of hospital and for the income level of the patient's area of residence.

It is possible that, due to limited resources, smaller hospitals may have under-reported comorbidities, which may have resulted in an overestimation of adjusted death rates for those hospitals. However,

using Empirical Bayes estimates for death rates, hospitals with smaller sample sizes (and therefore larger confidence intervals around the estimated death rate) would have had their death rates "shrunken" towards the mean, thereby attenuating the possible overestimation or underestimation of the death rate.

Another concern is that some hospitals may record secondary diagnoses better than other hospitals because of more stringent coding practices, independent of the size of the hospital. Although Levy et al. estimated the overall coding accuracy using a convenience sample of 6 Montreal hospitals (200), the authors did not address the systematic differences in coding accuracies that might occur across all Quebec hospitals. Such inaccuracies would result in differential misclassification biases being introduced if the hospitals that code comorbidities poorly also provide better or worse care than other hospitals.

The decision to use the Dartmouth-Manitoba adaptation of the Charlson Index may also have resulted in residual confounding as compared to the use of alternative tools. A second option considered for this study was the APR-DRG (All-Patient Refined Diagnostic Related Groupings) (148). The APR-DRG risk of mortality is calculated based on an algorithm that uses several variables such as secondary diagnoses and medical procedures conducted during the admission (241). It is a proprietary tool (242) that has been purchased and is used in Quebec and has been found to be a powerful risk adjustment tool (148). However, in Canada, all provinces except Quebec use an alternative tool, "Case Mix Groups with Complexity Overlay" (243). Given that the relative performance of hospitals may be influenced by the case mix tools selected (244;245), the Dartmouth-Manitoba adaptation of the Charlson Index was used due to its widespread use.

More recently, researchers in Ontario developed an AMI-specific risk adjustment tool, validating it on three separate hospital discharge databases (159). When comparing this model with the Deyo adaptation of the Charlson comorbidity Index, Tu and colleagues found their model to have better discriminative and predictive abilities. Although it would be interesting to replicate this study using this tool, the Dartmouth-Manitoba adaptation of the Charlson was selected because it remains a widely used comorbidity adjustment tool at this time.

Hospital ranks reported in this study are based on Empirical Bayes shrinkage estimators[17] (224). Without shrinkage, ordinary regression mortality rate estimates can be unstable due to small sample sizes for hospitals, and hospital performance may appear to be extreme purely as a result of chance. Therefore, identifying high and low outliers based on ordinary regression estimates may be misleading. The capacity to obtain more stable Empirical Bayes estimates in this study is particularly advantageous because it allowed for the inclusion of all hospitals in the analysis, in turn providing a more complete view of the outcomes of care of hospitals under study, whereas other methods of analysing these data require the exclusion of hospitals with smaller sample sizes.

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[17] Empirical Bayes shrinkage estimators were described in the Methods section entitled "Estimates of hospital performance". In summary, Empirical Bayes estimators for hospital-specific mortality rates take into account the degree of unreliability of the ordinary regression estimate. Specifically, the Empirical Bayes estimators will "shrink" the spread of hospital-specific mortality rates to a degree that reflects how far a given estimate is from the overall mean AND how stable the estimate is based on the number of patients admitted to a specific hospital.

Implications of this research

This work has important implications for the selection of methods used to conduct comparative hospital performance evaluations.

This study has found differences in hospital ranks, depending on the timeframe selected for outcome evaluation and on the method used to handle transfers. Relying on significant differences in hospital-specific mortality rates that identify outliers leads to different conclusions drawn regarding the best and worst performers, depending upon which methods are used.

In addition to these inconsistencies in performance ranks, statistical differences need also be clinically relevant. Clinical relevance in terms of differences in AMI patient mortality rates has not yet been explicitly defined for the purpose of conducting hospital performance studies. While randomized clinical trials have suggested that a 1% change in mortality rate represents a relevant and important clinical difference when testing new drugs for AMI patients (246), this amount may have been chosen somewhat arbitrarily and no such benchmark seems to have been identified specifically for performance evaluations. The need has been recognized to define clinically relevant differences in mortality for clinical trials that evaluate the efficacy of thrombolytic agents in AMI (247). Such efforts have not yet been initiated for hospital performance studies.

Absolute differences between hospital-specific mortality rates and overall mortality rates were as great as 3.62% and as small as 1.88% in this study, which both exceed the 1% change that is currently deemed to be clinically important when conducting cardiovascular drug trials. From this perspective, the findings of this study suggest significantly high or low mortality rates of outlier hospitals represent clinically important deviations from the overall rates.

These findings suggest that, on the one hand, the underlying processes of care in "outlier" hospitals may need to be investigated more closely in order to identify the factors contributing to the clinical differences in mortality rates between these outliers and other hospitals. On the other hand, without hospital performance measurement conventions it would be difficult to decide which methods to use and which results to base such an investigation on.

An important implication for this research is that these discrepancies in results may also occur for other indicators used to judge health care services. Hence, although this study has focused on hospital mortality rates among AMI patients as an indicator, it has raised some issues that may not have been sufficiently addressed in the literature for this and other indicators.

This study has also raised issues regarding the approaches available to examine and compare the impact of hospital performance evaluation methods. In other words, not only is there a need to compare the impact of different methods on the performance evaluation study results, there is also a need to identify which approach should be use when illustrating such an impact (rank correlations, quintiles, deciles or outliers among mortality rate ranks).

For example, among studies that have evaluated the impact of using various risk adjustment methods on hospital performance evaluation results (64;148;157;158;244;245), there have been inconsistencies in the criteria used to determine whether or not different study methods impact upon comparative evaluation results. Some researchers have compared the change in hospital ranks between quintiles or deciles (148;157;158;244), while others have compared each hospital's ranking

using various methods under study (64). This present study used four such approaches, highlighting the different perspectives in the sort of information obtained from each approach.

Unlike most hospital AMI mortality studies that have compared hospital performance levels, this study used Empirical Bayes shrinkage estimates. Had ordinary regression estimates been used, the absolute differences in the adjusted hospital-specific mortality rates would have been larger and the results would have appeared even more clinically important. Once again, without performance measurement conventions, hospital performance evaluation results that rely on rankings are even more questionable, or at best susceptible to influences related to the approaches used rather than to the actual differences between hospitals.

Future directions

This study addresses issues pertaining to measuring outcomes for performance evaluation whereas some researchers have measured processes of care that have been shown to be efficacious interventions (248). However, until clinical information systems, that can map processes of care and clinical outcomes, are made available, administrative databases will continue to be used to measure outcomes and, to a limited degree, processes of care. Furthermore, it is important to keep in mind that processes can improve without necessarily improving outcomes. For example, patient outcomes may deteriorate in a hospital demonstrating longstanding use of evidence-based guidelines if structures, such as staffing, are suddenly changed. Therefore, although not specifically addressed in this study, it is important to keep in mind that structure indicators can play a role in performance levels within the health care system (196).

Ongoing issues related to the uncertainty associated with measuring key covariates when using administrative databases can be addressed by making clinical information systems available on a widespread basis. Otherwise, this uncertainty will continue to impede on the ability to recognize "signals" amidst the "noise" when measuring indicators of the quality of care provided by hospitals. A more important by-product of this uncertainty is the residual bias that may result from inadequate measurement of confounding effects and that can lead to inaccurate results. As presented in the results section of this study, in the context of hospital performance studies, the "otherwise unexplained variation" between the hospital-specific death rates, after adjusting for patient and hospital characteristics, is considered to represent differences in the quality of care provided by different hospitals, see page 108, assuming all other factors have been explained. However, without clinical data available to determine the severity of the AMI or to establish the risk of mortality from AMI due to other predisposing factors not accounted for in administrative data, it is unlikely that differences in the quality of hospital care explain a major portion of the "otherwise unexplained variation". Indeed, the importance of properly adjusting for case mix differences is a longstanding concern for researchers working in the area of performance measurement (157;249) that will remain an important issue until adequate data are made available.

Ideally, clinical information systems would provide more complete data on a wide array of risk factors for medical conditions used to evaluate hospital performance. For example, risk factors for death due to cardiovascular disease are not typically included in administrative databases. Clinical information systems that could make data available on risk factors (such as blood pressure and smoking), on functional abilities (such as the ability to get out of bed and participate in rehabilitation after a heart attack), and

on other medical conditions (such as arthritis or low back pain that are not included in most comorbidity indices but that can nonetheless have an impact on the ability to engage in rehabilitation after a cardiovascular event) would address many of the current concerns regarding hospital performance evaluation. As countries and health authorities move towards making electronic health records more available, researchers will be better able to account for and incorporate data regarding these important confounders.

This study also highlights the need to develop hospital performance measurement guidelines. Conventions are needed to identify the confounding effects that should be accounted for in such studies. Confounding effects of key covariates may need to be compared across countries and jurisdictions that evaluate the quality of health care services in order to determine to what extent inter-jurisdiction comparisons can be made.

Clear guidelines regarding what differences in performance indicator levels should be deemed clinically important are also needed, as relying strictly on the presence or absence of statistical differences between levels of performance indicators is clearly not enough.

Conventions regarding timeframes to use for outcome evaluations have been discussed for some medical conditions but need to be established separately for key patient populations. Different timeframes may also be needed to evaluate the relative performance of health care delivery at different points in the health care continuum. For example, the differences found in this study between rankings based on in-hospital, 7-day mortality and 30-day mortality may actually reflect outcomes of different processes in the continuum of the treatment of AMI patients. Specifically, 7-day mortality may reflect the medical care provided to these patients, whereas

in-hospital may reflect the organisation and coordination of care within hospital and 30-day mortality may reflect the organisation and coordination of care between the hospital and community based services.

Finally, conventions regarding the methods used to deal with transferred patients are needed. Including transferred patients in hospital performance studies should be considered in jurisdictions where health services are regionalized and corridors of service call for stabilization of patients followed by timely transfers to appropriate facilities. This group of patients may be increasing in size as health systems try to become more efficient in their use of specialized resources and these corridors of service become better established in clinical practice.

Transferred patients may also need to be included in hospital performance studies conducted in jurisdictions where gaming can occur, consisting of transferring the most severely ill patients in order to avoid having deaths counted in a hospital's annual report card.

Conclusion

The methods used to define AMI mortality outcome, or to deal with transfers had an impact on which hospitals were identified as "outliers". Hospital reputations can be damaged by such findings. Furthermore, although this study was limited to comparing the impact on rankings based on AMI hospital mortality rates, other indicators of hospital performance may be influenced to a greater degree based on the methods used to deal with transferred patients.

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(249) Green J, Passman LJ, Wintfeld N. Analyzing hospital mortality. The consequences of diversity in patient mix. JAMA 1991; 265(14):1849-1853.

(250) Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. Radiology 1982; 143(1):29-36.

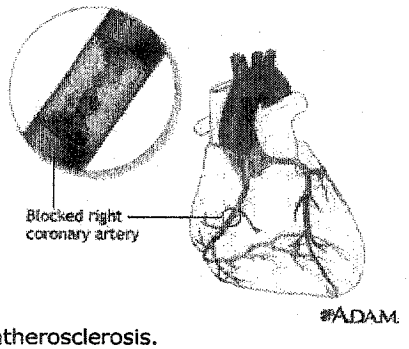
(251) Rosenthal GE, Shah A, Way LE, Harper DL. Variations in standardized hospital mortality rates for six common medical diagnoses: implications for profiling hospital quality. Med Care 1998; 36(7):955-964.

APPENDICES

List of Appendices

Appendix 1: Illustration of Revascularization Procedures: PTCA and CABG

Acute Myocardial Infarction

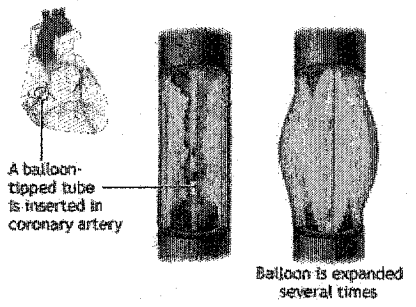


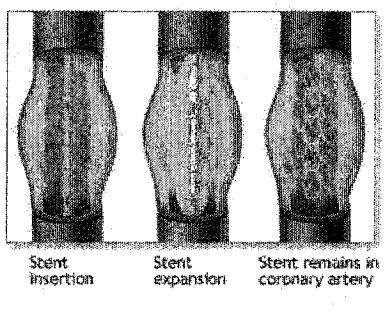
Acute myocardial infarction (AMI) is one of the most common diagnoses in hospitalized patients in industrialized countries. In the United States, approximately 1.1 million AMIs occur each year. The mortality rate with AMI is approximately 30%, with more than half of these deaths occurring before the stricken individual reaches the hospital. Although the mortality rate after admission for AMI has declined by about 30% over the last two decades, approximately 1 of every 25 patients who survives the initial hospitalization dies in the first year after AMI. Survival is markedly reduced in elderly patients (over age 75), whose mortality rate is 20% at 1 month and 30% at 1 year after AMI.

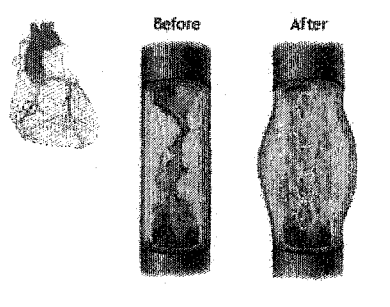
AMI generally occurs when coronary blood flow decreases abruptly after a thrombotic occlusion of a coronary artery previously narrowed by atherosclerosis.

Percutaneous Coronary Revascularization

Before 1977, bypass surgery was the only form of revascularization available to treat coronary artery disease. In that year, Andreas Gruntzig performed the first catheter-based coronary revascularization, which he named percutaneous transluminal coronary angioplasty (PTCA). With crude early equipment and limited anatomic capability, fewer than 1000 such procedures were performed worldwide annually until 1981. Through the 1980s and early 1990s, however, progressive improvements in the balloon angioplasty equipment led to improved results, expanded indications for use, and explosive growth in PTCA to the point that in the United States, the annual number of procedures (~300,000) roughly matched the number of surgical bypass operations.

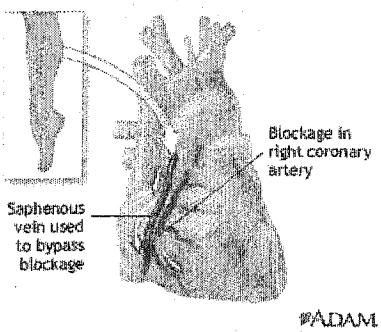


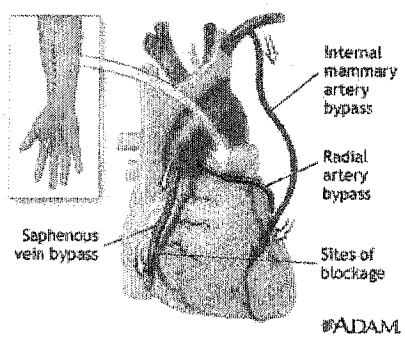




Coronary Artery Bypass Grafting

In CABG, a section of a vein (usually the saphenous) is used to form a connection between the aorta and the coronary artery distal to the obstructive lesion. Alternatively, anastomosis of one or both of the internal mammary arteries or a radial artery to the coronary artery distal to the obstructive lesion may be employed and is now preferred whenever possible.





Appendix 2: ACC/AHA Guidelines for the management of patients with acute myocardial infarction. 1999 update.

Management of Acute Myocardial Infarction

Date of last revision: September, 1999; AMI

Pharmacological Therapy

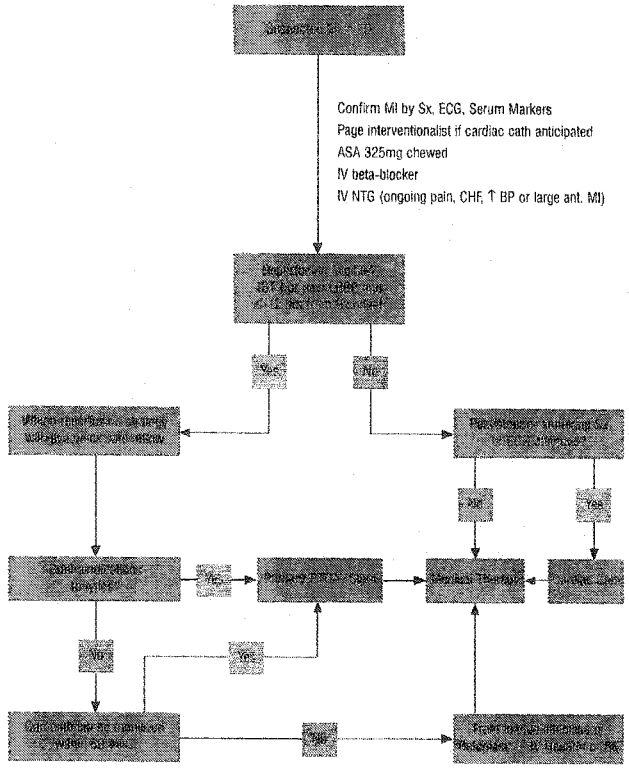
Medication	First 24 Hours	After First 24 Hours	Discharge
Aspirin	Chewed in ED (325mg)	160-325mg qd	81 mg qd indefinitely
Reperf for ST↑ or new LBBB ≤ 12 hrs of symptom onset	Front loaded Rx treatment fibrinolytics* (dosing on back of card) or Primary PTCA	Reperfusion: alteplase/reteplase can be repeated for recurrent occlusion	
Heparin (unfractionated UFH)	IV in alteplase, reteplase, PTCA treated patients and non-ST elevation MI; large or ant. MI, AF, prior embolus, LV thrombus 60 U/kg bolus, infusion 12 U/kg/hr (max 4000 U bolus/ 1000 U/hr infusion for pts > 70kg) to maintain aPTT 50-70 seconds	48 hrs in alteplase, reteplase treated patients: SubQ heparin for all until ambulatory	Coumadin for 3-6 months if LV thrombus seen or thromboembolism; chronically for AF
Low Molecular Weight Heparin (LMWH)	Subcutaneously (SC) 1mg/kg b.i.d. for patients with non-ST elevation MI if no contraindications; all patients not treated with fibrinolytics, if no contraindications (alternative to UFH)		
Beta-Blockers**	IV Metoprolol (up to 15mg in 3 divided doses) or IV Atenolol (10mg in 2 divided doses)	Oral Metoprolol 50-100mg daily or Atenolol 50-100mg qd or other beta-blockers	Oral daily indefinitely
ACE Inhibitors	Initial dose 6.25 mg captopril followed by 12.5 mg 2 hrs later, 25 mg 10-12 hrs later, then 50 mg b.i.d. or lisinopril 5 mg initially, 5 mg after 24 hrs, 10 mg after 48 hrs, then 10 mg daily	Daily for up to 6 wks	Longer if Sx CHF or LVEF ≤ 40%
GPIIb/IIIa	Tirofiban 0.4 ug/kg/min over 30 min, then infuse 0.1 ug/kg/min for non-ST elevated MI patients at high-risk (elevated serum markers, refractory ischemia)		
Nitroglycerin	IV for 24-48 hrs if no contraindications	Only for ongoing ischemia or uncontrolled hypertension	Oral for residual ischemia
Statins			Indefinitely if LDL-C > 100mg/dl
Hormone Replacement Therapy (HRT)		After 1st 24 hrs—should not be given de novo to postmenopausal women after acute MI. Women already taking HRT plus progestin at time of AMI can continue. Counsel all postmenopausal women about potential benefits of HRT.	Offer options of HRT

****Cautions/Relative Contraindications:** Heart rate < 60 bpm; PR interval > 0.24 seconds; severe PVD; SAP < 100mm Hg; 2nd or 3rd° AV block; IDDM; signs of peripheral hypoperfusion; severe COPD; severe LV failure; Hx of Asthma

Non-Pharmacological Therapy

Therapy	First 24 Hours	After First 24 Hours	Discharge
Dietary Advice		Education on low-fat diet	Recommend low-fat diet
Smoking	Reinforce cessation	Reinforce cessation	Referral to smoking cessation classes if desired
Exercise	Education	Hallway ambulation	Recommend regular aerobic exercise
Pre-discharge ETT	For uncomplicated patient plan on 4-5 days	Perform pre-discharge ETT	Cath patients with significant ischemia
Measure LVEF		ECHO or MUGA prior to d/c if no LV gram	ACE inhibitors if LVEF ≤ 40% or in-hospital CHF
Cardiac Rehabilitation		Start exercise	Refer to rehab program near their home

Patient Management



Indications for Cardiac Catheterization

- Primary PTCA
- Rescue for the failed fibrinolysis
- Clinical Conditions
  - Cardiogenic shock/hemorrhagic instability
  - CHF
  - Suspected mechanical complications eg. VSD, ruptured papillary muscle
  - Recurrent symptomatic arrhythmia
- Ischemia on pre-discharge ETT

Contraindications and Cautions for Fibrinolytic Use in Myocardial Infarction

Absolute Contraindications

- Previous hemorrhagic stroke at any time; other strokes or cerebrovascular events within 1 yr
- Known intracranial neoplasm
- Active internal bleeding (does not include menses)
- Suspected aortic dissection

Cautions/Relative Contraindications

- Severe uncontrolled hypertension on presentation (blood pressure >180/110 mm Hg)†
- History of prior cerebrovascular accident or known intracerebral pathology not covered in contraindications
- Current use of anticoagulants in therapeutic doses (INR ≥ 2-3); known bleeding diathesis
- Recent trauma (within 2-4 wks), including head trauma
- Noncompressible vascular punctures
- Recent (within 2-4 wks) internal bleeding
- For streptokinase/anistreplase: prior exposure (especially within 5d-2y) or prior allergic reaction
- Pregnancy
- Active peptic ulcer
- History of chronic hypertension

† Could be an absolute contraindication in low-risk patients with myocardial infarction.

*** Fibrinolytic Dosing** (from front of card)

Alteplase, 15mg bolus IV, followed by 50 mg over next 30 min, followed by 35 mg over next 60 min
Reteplase, double bolus 10 IU 30 min apart
SK, 1.5 million IU infused over 60 min

The following material was adapted from the *ACC/AHA Guidelines for The Management of Patients with Acute Myocardial Infarction: 1999 Update*. For a copy of the full report or Executive Summary as published in *JACC* and *Circulation*, visit our Web sites at *http://www.acc.org* or *http://www.americanheart.org* or call the ACC Resource Center at 1-800-253-4636, ext.694.

Appendix 3: Forms used by medical archivists to abstract data from medical records

ANNEXE 1.1

Gouvernement du Québec
Ministère de la Santé et des Services sociaux

MED-ÉCHO
ABRÉGÉ ADMISSION/SORTIE

PÉRIODE:

Enregistrement 1 / Correction 2 / Annulation 3 | N° d'admission | N° dossier médical

1 de l'établissement | Code | Type | Type d'admission | N° d'assurance-maladie

2 Nom du bénéficiaire à la naissance | Prénom du bénéficiaire

3 Adresse actuelle du bénéficiaire (N°, Rue, app.) | N° de téléphone | Nationalité | R | Etat civil | Date de naissance a m d | Sexe

4 Municipalité | Comté | Province | Code postal | Code municipal | Statut | Depuis quand? | N° d'assurance sociale | Lieu naiss.

5 Adresse antérieure (en cas de changement d'adresse dans les trois derniers mois) | Date du changement a m d | Admission antérieure | Nbre | Âge | Responsabilité du paiement

6 M D ou D D S recommandant | Adresse | Prénom du père | Nom de fille de la mère

7 Nom de l'employeur | Adresse | Téléphone | Occupation du bénéficiaire | Code d'occupation

8 Nom de la compagnie d'assurance: | N° de certificat | N° de contrat | N° de groupe | En cas d'urgence, avertir:

9 Logement requis | Privé | Semi-privé | Salle | N° de chambre | Per diem $

10 N° de permis d'ambulance | N° de voiture patrouille | Date d'accident a m d | Heure 0-24 | Code d'accident adm. E | Provenance du bénéficiaire | Type | Code d'établissement

11 Date d'admission a m d | Heure 0-24 | Médecin ou dentiste traitant | Code du médecin | Diagnostic d'admission | Code CIM-9 | État à l'admission

12 Service	Code du médecin	Nbre de jours	13 Diagnostic principal	14 Consultation	15 Trait. princ.	Nbre PI	Code du médecin	Date trait. m d	Code d'anesthésiste	Tech anes.	A.P.
1											
2											
4											

Autre diagnostic | Autre diagnostic | Autre diagnostic

16 T	Topo.	Morpho	D.	Topo.	Morpho.	D.	Topo.	Morpho.	D.	Études spéc.	Accident
		M			M			M			E

17 Décès: Type | ± 48 | Autopsie | Mortinaissance: Nbre | Autopsie | Masse à la naissance (en kg) | Durée de la gestation (semaines) | N° de dossier de la mère | Études spéc. | Accident E

18 Date du congé a m d | Date de sortie a m d | Heure 0-24 | Jours de congé temporaire | Séjour total | Destination du bénéficiaire | Type | Code d'établissement

Renseignements supplémentaires | Date inscr. urgence a m d

Je demande pour moi-même, ou le bénéficiaire ci-dessus nommé, les avantages de la Loi de l'assurance-hospitalisation du Québec. J'accepte de payer le supplément journalier de $ pour une chambre privée ou semi-privée de soins de courte durée, ou le montant en vertu de cette loi et de ses règlements pour une salle, chambre privée ou semi-privée de soins de longue durée, ainsi que l'intérêt, au taux légal, couru à partir du 30e jour suivant la date de l'état de compte qui me sera adressé. J'assume l'entière responsabilité financière de l'hospitalisation à compter de la date du congé autorisé par le médecin traitant.

I ask for the benefits of the Loi de l'assurance-hospitalisation du Québec for myself, or for the above named recipient. I agree to pay the day additional rate of $ for a private or semi-private room for short term care or to assume the cost, as determine by this same Act and the accompanying regulations, for standard ward accomodations or a private or semi-private room for long term care, plus interest, at legal rate, calculated from the 30th day following the date on the statement of accounts addressed to me. I assume full financial responsability for hospitalization subsequent to the date of discharge authorized by the attending physician.

Signature du bénéficiaire ou garant | Témoin

AH-101P (rev. 87-11)

Appendix 4: Death Certificate form

Gouvernement du Québec
Ministère de la Santé et des Services sociaux

Management entrusted to the
Bureau de la statistique du Québec

SP-3 *Return of* Death

Please type or print in block letters using a ball-point pen. Do not write in shaded spaces. Press firmly.

PLACE OF DEATH

1. Name of institution where death occurred
2. Code of institution
3. Exact location where death occurred (No., street, municipality, province or country) — Postal code

IDENTIFICATION OF DECEASED (Write the surname and given name(s) according to the Act of Birth)

4. Surname
6. Health insurance No.
5. Usual given name
7. Birthdate — Year : Month : Day :
8. Age at death ▶ If over 1 year — Year(s) : : If under 1 year — Month(s) : Day(s) : If under 24 hours — Hour(s) : Minute(s) : If under 7 days, give weight at birth — Grams : : :
9. Marital status
   1 ☐ Single (never married) 2 ☐ Married 3 ☐ Widowed 4 ☐ Divorced 5 ☐ Legally separated
10. Name of spouse of the deceased
11. If deceased married, give age of spouse
12. Birthplace (Province or country)
13. Language spoken at home
   01 ☐ French 02 ☐ English Other _____
14. Address of deceased's domicile (No., street, municipality, province or country) — Postal code
15. Surname of mother (according to the act of birth)
16. Usual given name of mother
17. Surname of father
18. Usual given name of father

MEDICAL CERTIFICATION OF DEATH

19. Date and time of death — Year : Month : Day : Hour : Minute :
20. Sex of deceased — 1 ☐ Male 2 ☐ Female 9 ☐ Undetermined
21. Notice to the coroner (see guidelines on back of copy 1) — 1 ☐ Yes 2 ☐ No
22. Causes of death — Approximate interval between onset and death ▼

1. **Disease or condition directly** leading to death*
   (a) _____
   Antecedent causes. Morbid conditions, if any, giving rise to the above cause, stating the underlying condition last
   due to *(or as a consequence of)*
   (b) _____
   due to *(or as a consequence of)*
   (c) _____
   (underlying cause)
2. **Other significant conditions** contributing to the death, but not related to the disease or condition causing it

PRESS FIRMLY

* *This does not mean the mode of dying, e.g., heart failure, asthenia, etc. It means the disease, injury or complication which caused death.*

For office use only

23. Autopsy? 1 ☐ Yes 2 ☐ No
   If yes, does the cause of death stated above take autopsy findings into account? 1 ☐ Yes 2 ☐ No
24. Presence of radioisotopes 1 ☐ Yes 2 ☐ No
25. If deceased a woman, did the death occur during pregnancy or within 42 days thereafter? 1 ☐ Yes 2 ☐ No
26. Deceased suffered from a disease that must be declared 1 ☐ Yes 2 ☐ No
   Specify _____
27. If the case of violent death, check *FOR STATISTICAL USE ONLY*
   ☐ Accident ☐ Suicide ☐ Homicide
28. Place (farm, factory, etc.) and circumstances (drowning, strangulation, etc.)
29. Is author of medical certification a 1 ☐ Physician 4 ☐ Coroner ☐ Other _____
30. Surname and given name of author of medical certification
31. Tel. No. where author can be reached — Area code
32. Address (No., street, municipality, province) — Postal code

I have reported, to the best of my knowledge, the causes and the circumstances surrounding the death of this person. The information collected is transmitted to the Bureau de la statistique du Québec, to the ministère de la Santé et des Services sociaux, to the funeral director and to the Registrar of Civil Status. The information is subject to the provisions of the Act respecting Access to documents held by public bodies and the Protection of personal information, except with respect to the Registrar of Civil Status who is not subject to that Act. The conditions are listed on the back of page 2.

X

33. Signature of author of medical certification
34. Date signed
35. If a physician, give permit No. (Corp. des médecins)

DISPOSAL OF BODY / FUNERAL DIRECTOR

36. Disposal arrangements
   1 ☐ Burial 2 ☐ Cremation 3 ☐ Anatomical study 4 ☐ Body transported outside Québec
37. Name of funeral home
38. Permit No. (funeral director)
39. Address of funeral home (No., street, municipality, province or country) — Postal code
40. Date on which body was handed over — Year Month Day
41. Surname and given name of representative of funeral home
42. Signature of representative
   X

SP-3 (95-11)

3- 4854842

1- BUREAU DE LA STATISTIQUE DU QUÉBEC

Appendix 5: Request for data, submitted to Commission d'accès à l'information

Commission d'accès à l'information du Québec

Siège social
575, rue St-Amable, bureau 1.10
Québec (Québec) G1R 2G4
Téléphone: (418) 528-7741
Télécopieur: (418) 529-3102

Bureau de Montréal
480, boul. St-Laurent, bureau 501
Montréal (Québec) H2Y 3Y7
Téléphone: (514) 873-4196
Télécopieur: (514) 844-6170

Québec, le 11 juin 2002

Madame Nancy E. Mayo
Division d'épidémiologie clinique
Hôpital Royal Victoria (Centre
universitaire de santé McGill)
687, avenue Des Pins Ouest
Bureau R4.27
Montréal (Québec)

N/Réf. : 02 04 58

Madame,

Nous avons bien reçu votre demande d'autorisation d'obtenir, pour votre étude « *L'évaluation de la performance des hôpitaux : une étude méthodologique de l'impact du profil d'admission et des transferts sur le taux de mortalité inter-hospitalier* », communication de renseignements nominatifs détenus par le ministère de la Santé et des Services sociaux (MSSS). Nous désirons souligner la qualité de présentation et le souci du détail rencontrés dans votre demande, les variables dont vous souhaitez la communication et leur justification étant particulièrement bien étayées.

Après étude de cette demande et conformément à l'article 125 de la *Loi sur l'accès aux documents des organismes publics et sur la protection des renseignements personnels,* nous vous autorisons à recevoir du MSSS les renseignements nominatifs suivants pour les années 1991 à 1999 :

➢ *de la base de données MED-ÉCHO du MSSS :*

- un numéro matricule **brouillé** de chaque patient sous étude,
- le code d'établissement,
- le code RSS/DSC/CLSC de l'établissement,
- le type d'établissement,
- le type d'admission,
- le code d'âge du/de la bénéficiaire,
- le sexe,
- la première moitié du code postal (séquence lettre-chiffre-lettre) de chaque bénéficiaire,

- la date d'accident,
- le code d'acccident,
- le code de provenance,
- le type de provenance,
- la date d'admission,
- le diagnostic principal,
- le regroupement D19 du diagnostic principal,
- le regroupement D119 du diagnostic principal,
- le code de soins intensifs 1 à 3 : unité 1 à 3,
- le code de soins intensifs 1 à 3 : nombre de jours 1 à 3,
- les diagnostics secondaires (1 à 15),
- le traitement (1 à 9),
- le regroupement T18 (1 à 9),
- le regroupement T99 (1 à 9),
- le nombre de traitements (1 à 9),
- la date de traitement (1 à 9),
- la date d'inscription à l'urgence,
- le code d'accident 2 à 3,
- la variable 'décès-type',
- la variable 'décès dans les 48 heures',
- la date complète de sortie,
- les jours de congé temporaires,
- le séjour total,
- le type de destination,
- le code de destination,
- le RSS de chaque bénéficiaire,
- le DSC de chaque bénéficiaire,
- le CLSC de chaque bénéficiaire.

➢ *de la banque "Statistiques démographiques" K29 - DÉCÈS du MSSS :*

- un numéro matricule **brouillé** de chaque patient sous étude,
- la date de son décès,
- le code d'établissement,
- la cause médicale du décès.

Nous prenons acte que le jumelage et le brouillage des informations seront effectués par le détenteur de ces informations, soit le MSSS. Aux fins d'assurer une certaine sécurité eu égard à ces informations, nous recommandons que des mesures soient prises pour que l'*accès à l'ordinateur* de table auquel elles seront intégrées *soit sécurisé et restreint* à l'usage des seuls chercheurs ou chercheuses.

Cette autorisation est cependant assortie des conditions suivantes que vous devez respecter :

M-3

Centre universitaire de santé McGill
McGill University Health Centre

DIVISION D'ÉPIDÉMIOLOGIE CLINIQUE
DIVISION OF CLINICAL EPIDEMIOLOGY

Nancy Mayo Ph.D.
James McGill Professor
Nancy.mayo@mcgill.ca

21 mars, 2002

Madame Louise Légaré
MSSS
1005 Chemin St-Foy
4ième étage, service développement et diffusion
QC G1S 4N4

Objet: Demande d'autorisation à la CAI :
« Évaluation de la performance des hôpitaux : une étude méthodologique de l'impact du profil d'admission et des transferts sur le taux de mortalité inter-hospitalier. »

Madame Légaré:

Je vous envoie une copie d'une nouvelle demande faite à la Commission d'accès à l'information du Québec.

N'hésitez pas à communiquer avec moi si vous avez besoin de plus amples informations à ce sujet. Je vous prie, Madame Légaré, d'agréer l'expression de mes sentiments les meilleurs.

Lyne Nadeau
Assistante de recherche pour Nancy Mayo, Ph.D.
(514) 842-1231 poste 36906
lyne.nadeau@clinepi.mcgill.ca

Centre universitaire de santé McGill
McGill University Health Centre

DIVISION D'ÉPIDÉMIOLOGIE CLINIQUE
DIVISION OF CLINICAL EPIDEMIOLOGY

Nancy Mayo Ph.D.
James McGill Professor
Nancy.mayo@mcgill.ca

21 mars, 2002

Monsieur Jean Foisy
Commission d'accès à l'information du Québec
575, rue St-Amable, bureau 1.10
Québec (Qc)
G1R 2G4

Objet: Évaluation de la performance des hôpitaux : une étude méthodologique de l'impact du profil d'admission et des transferts sur le taux de mortalité inter-hospitalier.

Monsieur Foisy,

Je vous envoie une demande d'autorisation pour un nouveau projet tel que discuté récemment au téléphone. J'envoie aussi une copie à Mme Louise Légaré du service de l'infocentre du MSSS.

N'hésitez pas à communiquer avec moi si vous avez besoin de plus amples informations à ce sujet. Je vous prie, Monsieur Foisy, d'agréer l'expression de mes sentiments les meilleurs.

Lyne Nadeau
Assistante de recherche pour Nancy Mayo, Ph.D.
Tél.:(514) 842-1231 poste 36906
Fax: (514) 843-1493
lyne.nadeau@clinepi.mcgill.ca

Commission d'accès à l'information du Québec

NUMÉRO DE DOSSIER ANTÉRIEUR*

*S'il y a lieu

RÉSERVÉE À LA COMMISSION
DOSSIER NO.

CODE DE L'ORGANISME

FORMULAIRE DE DEMANDE D'AUTORISATION DE RECEVOIR DES RENSEIGNEMENTS NOMINATIFS À DES FINS DE RECHERCHE, D'ÉTUDE OU DE STATISTIQUE

CHERCHEUR

Nom : Nancy E. Mayo, PhD

Adresse : Division d'épidémiologie clinique, R4.27
Hôpital Royal Victoria; 687, avenue des Pins Ouest; Montréal (Québec) H3A 1A1

Téléphone : 514-842-1231 (poste 36906)

ORGANISME DÉTENTEUR DES RENSEIGNEMENTS

1.Nom : MSSS Service de la gestion des données
(MedÉcho et la banque de données « Statistiques démographiques » pour les décès)
Adresse : 1525 chemin St-Louis, 4ième étage, dépôt du courrier 49
Téléphone : (418) 682-5163
Nom de la personne contactée : Louise Légaré

EXIGENCES	INFORMATIONS À FOURNIR PAR LE CHERCHEUR	RÉSERVÉ À LA COMMISSION COMMENTAIRES ET RECOMMANDATIONS DE L'ANALYSTE
1. A) OBJET DE LA RECHERCHE *Joindre un résumé du protocole de recherche*	Le but de cette étude est de déterminer l'influence que les transferts inter-hospitaliers ont sur les études comparatives de la performance des hôpitaux. Actuellement, les enquêtes utilisent le taux de mortalité comme indice de cette performance. Nous adresserons cette question exclusivement aux patients atteints d'un infarctus du myocarde aigu. *Voir le résumé du protocole de recherche à l'annexe I*	
1. B) TAILLE DE L'ÉCHANTILLON	Dans cette population, nous prévoyons environ 17,000 épisodes de soins par année, ce qui représente 136,000 épisodes sur huit ans. Une telle étude nécessite cette période prolongée à cause de changements de protocoles cliniques qui ont eu lieu lors des dix dernières années et qui pourraient influencer les résultats. Il est donc impératif de tenir compte de ces changements dans notre analyse.	
1. C) ÉTAPES DE LA RECHERCHE	Voir l'annexe II	

EXIGENCES	INFORMATIONS À FOURNIR PAR LE CHERCHEUR	COMMENTAIRES ET RECOMMANDATIONS DE L'ANALYSTE
. RENSEIGNEMENTS NOMINATIFS	Les variables demandées au MSSS sont énumérées à l'annexe III	
3. JUSTIFICATION DE LA NÉCESSITÉ DES RENSEIGNEMENTS NOMINATIFS	Nous décrivons à l'annexe III, la nécessité de chaque variable demandée. Environ cinquante pour cent des décès, suite à un infarctus du myocarde a lieu en dehors des hôpitaux. Cela signifie que les décès qui ont lieu ailleurs, par exemple à domicile ou en route vers l'hôpital, ne sont pas saisis dans la base de données Med-Écho. L'exclusion de ces décès mène à une sous-estimation du taux de mortalité, qui pourrait causer des résultats erronés. Afin de pouvoir obtenir cette information pour tout les patients inclus dans l'étude, nous devons fusionner les données de Med-Écho et celles de la banque de données « Statistiques démographiques » pour les décès. De plus, pour déterminer si chaque décès est associé à un infarctus du myocarde, nous avons besoin de la variable nominative « cause du décès ».	
4. IMPOSSIBILITÉ D'OBTENIR LE CONSENTEMENT	Chaque année, il y a au-delà de treize milles patients qui sont admis pour un infarctus du myocarde. Les études d'enquêtes de la performance des hôpitaux exigent que les analyses se fassent sur plusieurs années. Sinon, il n'y a pas suffisamment de pouvoir statistique pour arriver à des conclusions évidentes, c'est à dire que le résultat manque de précision. Si l'échantillon n'est pas assez grand, les différences de performance inter-hospitalières ne pourront être distinguées des effets qu'ont les variables de confusions sur le taux de mortalité. Étant donné que nous n'identifierons pas des individus, nous n'envisageons pas d'obtenir de consentements.	

EXIGENCES	INFORMATIONS À FOURNIR PAR LE CHERCHEUR	RÉSERVÉ À LA COMMISSION COMMENTAIRES ET RECOMMANDATIONS DE L'ANALYSTE
5. MÉTHODES DE CONTACT Y A-T-IL CONTACT ENTRE LE CHERCHEUR ET LES PERSONNES À L'ÉTUDE ? OUI _____ DÉCRIVEZ-LE ET PROUVEZ LE CONSENTEMENT NON _____ DANS CE CAS-CI, PASSEZ À LA QUESTION 6	Non, il n'y aura aucun contact entre la chercheure et les personnes à l'étude.	
6. SUPPORT ET MODE DE TRANSMISSION DU SUPPORT Support_____ _____ _____ Transmission _____ _____	Les données seront transmises sur disque compact, et seront livrées directement à la chercheure par service de courrier spécial. Celles-ci seront installées immédiatement dans un ordinateur de table, où s'effectueront toutes les analyses nécessaires. L'identité des individus ne sera ni disponible ni accessible aux chercheurs. Les résultats seront transmis sous forme de taux ou de moyennes, sans qu'aucune identité ne soit divulguée.	
7. MESURES DE SÉCURITÉ	Toutes les données seront conservées sous clé. Elles ne seront accessibles qu'à l'individu qui effectuera les analyses, soit une étudiante au doctorat sous l'égide de la chercheure, Dr Nancy E. Mayo.	
8. JE M'ENGAGE FORMELLEMENT, • À protéger la confidentialité des renseignements personnels reçus et à faire signer un protocole de confidentialité à tous les membres de l'équipe de recherche; • À ne publier aucun renseignement permettant d'identifier des individus dans mes rapports de recherche; • À n'utiliser les renseignements que pour cette seule recherche et à ne pas les transférer à d'autres personnes que celles autorisées à les recevoir dans le cadre de cette recherche. SIGNATURE DU OU DES CHERCHEURS _____ _____ _____ _____ _____		

EXIGENCES	INFORMATIONS À FOURNIR PAR LE CHERCHEUR	COMMENTAIRES ET RECOMMANDATIONS DE L'ANALYSTE
9. CONDITIONS DE MISE EN ŒUVRE		

Période de temps requise _____

Les renseignements seront-ils détruits ou retournés à l'organisme ? Les données seront détruites suite à l'étude

RECOMMANDATION DE L'ANALYSTE : Acceptée _____

Modifiée _____

_____

_____

Refusée _____

Signature _____ Date _____

DÉCISION DE LA COMMISSION : Acceptée _____ Modifiée _____ Refusée _____ Date _____

MODIFICATION(S) DE LA COMMISSION : _____

_____

_____

_____

SANCTION OFFICIELLE : _____

Annexe 1

Résumé du protocole de recherche

Titre du Projet:
L'Évaluation de la performance des hôpitaux : une étude méthodologique de l'impact du profil d'admission et des transferts sur le taux de mortalité inter-hospitalier.

Résumé :
La question de la qualité des soins hospitaliers est importante pour le public, les prestataires et les décideurs. Les résultats des enquêtes mesurant la qualité des soins sont de plus en plus diffusés dans la presse et les médias. Il est donc normal que de tels résultats nous préoccupent lorsqu'un hôpital est identifié comme offrant des services médiocres. Nous ne devons tout de même pas oublier que ces études font face à certains défis méthodologiques que les chercheurs ne maîtrisent pas toujours de façon consistante. Il existe plusieurs façons de tenir compte des effets de la composition de la clientèle (patients) et des transferts inter-hospitaliers. L'approche utilisée peut avoir une influence importante sur la validité des résultats obtenus. Par exemple, une étude effectuée par un groupe de consultants a conclu qu'un hôpital montréalais avait, pendant deux ans de suite, le taux de mortalité le plus élevé de tous les hôpitaux participant à l'enquête. Comme dans tant d'autres enquêtes, celle-ci n'a malheureusement pas pris en considération ni les transferts qui ont eu lieu ni la composition de la clientèle. Pourtant, l'hôpital en question reçoit régulièrement les cas les plus sévères de la région, soit directement, soit par l'entremise d'autres hôpitaux qui les lui transfèrent.

Notre étude cherche à mieux comprendre, dans le contexte des études de la qualité des soins, l'impact des transferts inter-hospitaliers sur les résultats comparatifs du taux de létalité.

Notre hypothèse est que le taux de mortalité changera selon l'approche utilisée pour prendre en compte ces transferts inter-hospitaliers.

Nous utiliserons les données de Med-Écho. La population cible sera tous les adultes qui ont subi au moins un infarctus du myocarde aigu et qui ont reçu leur congé d'un hôpital de soins de courte durée au Québec, entre les années 1992 et 1999. Nous avons choisi la maladie de l'infarctus du myocarde aigu car elle est courante, le risque de mortalité est élevé et les résultats des séjours hospitaliers sont sensibles à la qualité des soins offerts.

Pour ces personnes, un épisode de soins représente souvent plus d'un séjour à l'hôpital. Il est également concevable qu'au cours d'un épisode de soins, un patient retourne à la maison plus d'une fois. Nous ferons le suivi nécessaire pour bien définir chaque épisode de soins, du début à la fin.

Dans cette clientèle cible, environ cinquante pour cent des patients meurent à domicile ou en route à l'hôpital. Ils ne figurent donc pas dans la banque de données de Med-Écho lors de leur décès. Ceci pose un problème lorsque le décès est figuratif du résultat d'un épisode de soins écourté. Afin de déterminer le résultat réel d'un épisode de soins, nous devons pouvoir

identifier tous les décès, qu'ils aient eu lieu à l'hôpital ou ailleurs, dans les 30, 60, 90 jours ou plus, suite au congé de l'hôpital.

Nous prévoyons environ 17,000 épisodes de soins par année. Les matricules des patients seront brouillés et il nous sera impossible d'identifier les individus.

Nous allons étudier huit ans de données car, au cours de cette période, il y a eu des changements considérables dans les protocoles cliniques qui devront être pris en considération.

Annexe 2

Étapes de la recherche

1. Nous ferons une demande auprès de Med-Écho.
2. Nous leur demanderons de nous faire parvenir les variables énumérées à l'annexe 3, après avoir fait une fusion des fichiers de Med-Écho et de la banque de données «Statistiques démographiques» pour les décès.
3. Les données seront requises pour l'ensemble des patients qui ont reçu un congé hospitalier entre 1992 et 1999, excluant :
    a. Les patients âgés de moins de 18 ans
    b. Les non-résidents du Québec
    c. Les séjours hospitaliers dans les établissements de soins psychiatriques ou de soins pédiatriques
4. Nous demanderons que les données de Med-Écho relatives aux patients sélectionnés (1992-1999) couvrent la période de la collecte de données (1991-99). La période d'analyse des données débutera un an avant la période de sélection des patients afin que nous puissions :
    a. Définir les épisodes de soins pour ses patients
    b. Valider l'indice de comorbidité « Charlson Comorbidity Index ».
5. Tous les patients ayant eu au moins un diagnostic principal d'un infarctus du myocarde seront retenus. Nous identifierons ensuite tous les séjours hospitaliers effectués par ces patients.
6. Nous reconstituerons les épisodes de soins, définis comme étant une série de séjours consécutifs, de moins de 30 jours entre la date de sortie d'un séjour hospitalier et la date d'admission du prochain séjour.
7. Nous ne conserverons que les épisodes de soins relatifs au diagnostic de l'infarctus du myocarde aigu.
8. Les variables suivantes seront crées à partir des variables incluses dans la base de données Med-Écho :
    a. Série de variables qui décrivent l'hôpital où le séjour a eu lieu (capacité en lits de courte durée, affiliation universitaire, région géographique); variable Med-Écho utilisée : le numéro de l'hôpital.
    b. La proportion de la population en dessous du seuil de faible revenu selon la région de tri d'acheminement du bénéficiaire (information obtenue dans le recensement de 1996); variable Med-Écho utilisée : les 3 premiers chiffres du code postal du bénéficiaire.
    c. L'indice de co-morbidité « Charlson Comorbidity Index » sera construit pour chaque patient à partir des quinze diagnostics secondaires de Med-Écho.
    d. Un indice de sévérité sera développé à partir des variables incluses dans Med-Écho comme suit :
        i. Type d'admission
        ii. Date d'accident
        iii. Code d'accident
        iv. Code de provenance
        v. Type de provenance
        vi. Soins intensifs (unité et nombre de jours)

vii. Traitement (code du traitement selon la Classification canadienne des actes diagnostiques, thérapeutiques et chirurgicaux (2ème révision) - CCADTC, le nombre et la date de chaque traitement)
viii. Date d'inscription à l'urgence
ix. Code de destination

9. À partir de la reconstruction des épisodes de soins, nous serons en mesure de définir les schémas de transferts inter-établissements. Une séquence de transferts pourrait comprendre les étapes suivantes :
    a. Transfert à un établissement équipé pour un traitement ou un acte diagnostic
    b. Transfert à un hôpital universitaire spécialisé
    c. Retour du bénéficiaire à l'hôpital d'origine
    d. Réadmission dans les trente jours suite au congé accordé au patient
10. Nous déterminerons les séquences de transferts les plus courantes
11. Nous analyserons l'influence des schémas de transferts sur le taux de létalité parmi les patients atteints d'un infarctus du myocarde aigu. Nous utiliserons un modèle statistique hiérarchique pour de contrôler les variables à plusieurs niveaux simultanément :
    a. Les variables attribuables à l'individu
        i. Le diagnostic principal
        ii. L'âge
        iii. Le sexe
        iv. L'indice de co-morbidité
    b. Les variables attribuables à l'hôpital
        i. La capacité en nombre de lits de courte durée
        ii. Le nombre de patients admis annuellement avec le diagnostic principal « infarctus du myocarde »
        iii. La densité de la population dans la région où se situe l'hôpital
        iv. L'affiliation universitaire de l'établissement
    c. Les variables écologiques
        i. La proportion de la population en dessous du seuil de faible revenu selon la région de tri d'acheminement du bénéficiaire (information obtenue du recensement de 1996)
        ii. La densité de la population selon la région de tri d'acheminement du bénéficiaire (information obtenue du recensement de 1996)
        iii. Le nombre de lits disponible par habitant dans la région socio-sanitaire (ou le territoire du CLSC du bénéficiaire)
        iv. La distance entre le cœur du territoire du CLSC du bénéficiaire et le centre hospitalier le plus proche.

Annexe 3a

VARIABLES SUR LES SOINS HOSPITALIERS POUR LE PROJET :
L'Évaluation de la performance des hôpitaux :
Une étude méthodologique de l'impact du profile d'admission et des transferts sur le taux de mortalité inter-hospitalier.
SOURCE: BASE DE DONNÉES MED-ÉCHO (MSSS)

VARIABLE		GENRE	LONGUEUR	JUSTIFICATION
1	Matricule du patient (brouillé) (NAM)	X	12	Ce numéro d'identification unique servira à rattacher les séjours consécutifs ce qui permettra de construire les épisodes de soins. On définit un épisode de soins comme une série de séjours consécutifs ayant moins de 30 jours entre la date de sortie d'un séjour hospitalier et la date d'admission de la prochaine hospitalisation. Notons que le matricule du patient est la variable que nous utiliserons pour fusionner les deux bases de données nécessaires, celle de MedÉcho et celle de la banque de données « Statistiques démographiques » pour les décès.
2	Code d'établissement	P	5	Cette variable nous permettra d'identifier chaque hôpital afin de lui attribuer les caractéristiques recueillies au préalable; ex : l'affiliation universitaire, le nombre de lits de soins de court terme, le nombre de patients répondants au diagnostic principal étudié et la région où se situe l'hôpital. Ces variables, dites attribuables à l'hôpital, ont été identifiées dans la littérature scientifique comme des variables de confusion. De plus, dans le contexte des études de l'assurance de la qualité, les revues scientifiques exigent que le nom des établissements soit disponible pour toute publication (REF : CMAJ Jan 2002)
3	RSS / DSC / CLSC de l'établissement	X	5	Cette variable contribuera à la définition de l'ensemble des attributs de l'établissement, dépendamment de l'emplacement de l'hôpital situé dans une région urbaine, urbaine universitaire ou rurale.
4	Type d'établissement	P	2	Nous devons pouvoir faire la distinction entre les établissements de soins de courte durée et ceux de longue durée, de soins psychiatriques ou de soins pédiatriques.
5	Type d'admission	P	1	Le type d'admission (urgente, semi-urgente, élective) influencera la cote attribuée au patient selon l'indice de sévérité que nous développerons pour la maladie sous étude.
6	Code d'âge du bénéficiaire	P	3	L'âge est une variable de confusion reconnue que nous devons prendre en considération lors de l'étude du lien entre l'hôpital et le décès du patient.
7	Sexe	A	1	Le sexe est également une variable confusion qui nécessite d'être contrôlée.

VARIABLE		GENRE	LONGUEUR	JUSTIFICATION
8	Code postal (RTA) du bénéficiaire (trois premières lettres du code postal)	X	3	Les variables écologiques (c'est à dire les caractéristiques de l'ensemble des bénéficiaires en provenance d'une région particulière) doivent être considérées. La littérature scientifique a démontré des liens entre certaines caractéristiques socio-démographiques et la mortalité. Cette variable nous permettra de faire le lien entre la RTA (région de tri d'acheminement) auquel appartient le patient et les caractéristiques socio-démographiques de l'ensemble des résidents de cette RTA (par exemple, le seuil de faible revenu, la classification de la région : rurale, urbaine, banlieusarde; etc) qui sont disponibles dans le Recensement Canada, 1996. Nous estimons que cette classification sera suffisamment précise et que nous ne devrons pas identifier les cas particuliers.
9	Date d'accident (AAMMJJ)	P	4	Cette variable nous permettra de déterminer si l'infarctus du myocarde est associé à un accident pré-admission ou non. Dans l'affirmative d'un accident pré-admission, le processus de soins diffère de celui de la majorité des patients souffrants d'un infarctus du myocarde. Ces cas ne devraient pas figurer dans notre étude. D'autre part, si l'accident avait lieu lors du séjour hospitalier, cela pourrait représenter une complication des soins.
10	Code d'accident	P	3	Cette variable nous aidera à faire la distinction entre la sévérité de la maladie du patient et la possibilité d'une complication due aux soins dispensés.
11	Code de provenance	P	8	Cette variable nous permettra d'identifier tous les séjours consécutifs et de déterminer si ceux-ci appartiennent au même épisode de soins ou pas. La variable contribuera également à définir le degré de sévérité de l'état de santé du patient, puisqu'il est concevable que les patients transférés des centres hospitaliers communautaires aux centres de soins spécialisés sont gravement malades. Enfin, le code de provenance nous permettra de définir certains des attributs associés au transfert d'un patient entre deux établissements, entre-autre, la distance.
12	Type de provenance	P	2	Cette variable sera utilisée en concomitance avec celle si-dessus mentionnée afin d'établir le degré de sévérité de l'état de santé du patient transféré.
13	Date d'admission (AAMMJJ)	P	4	Cette variable nous permettra d'identifier les admissions consécutives de manière à construire nos épisodes de soins. Elle nous permettra aussi de contrôler l'effet de confusion résultant du temps écoulé lors de notre étude, du fait que les lignes directrices de la pratique clinique ont évolué au cours des dernières années. De plus, la date d'admission nous permettra de déterminer la durée de chaque séjour de même que la durée de chaque épisode de soins.

VARIABLE		GENRE	LONGUEUR	JUSTIFICATION
14	Diagnostic principal	X	6	Nous devrions être en mesure d'identifier tous les diagnostics associés à l'infarctus du myocarde.
15	Regroupement D19 du diagnostic principal	P	2	Cette variable nous permettra de regrouper les patients selon une classification plus globale que celle du diagnostic principal, en guise de statistiques descriptives.
16	Regroupement D119 du diagnostic principal	P	3	Cette variable nous permettra de regrouper les patients selon une classification plus globale que celle du diagnostic principal, en guise de statistiques descriptives.
17 à 19	Soins intensifs 1 à 3: Unité 1 à 3	N	2	Cette variable contribuera au niveau de sévérité du cas selon un indice développé pour notre étude.
20 à 22	Soins intensifs 1 à 3: nombre de jours 1 à 3	N	2	Un séjour prolongé dans une unité de soins intensifs indique la sévérité importante du cas.
23 à 37	Diagnostics secondaires 1 à 15	X	7	Cette variable nous permettra de calculer l'indice de comorbidités chez chaque bénéficiaire selon l'échelle de « Charlson Comorbidity Index »
38 à 46	Traitement (1 à 9)	X	5	Cette variable contribuera au niveau de sévérité du cas selon l'indice développé pour notre étude. Elle nous permettra également de définir certaines variables clés au niveau de l'établissement telles que la capacité d'offrir certains traitements spécialisés ou le volume annuel de procédures cliniques associées au diagnostic sous étude.
47 à 55	Regroupement T18 (1 à 9)	P	2	Cette variable nous permettra de regrouper les procédures selon une classification plus globale que le traitement précis en guise de statistiques descriptives.
56 à 64	Regroupement T99 (1 à 9)	P	3	Cette variable nous permettra de regrouper les procédures selon une classification plus globale que le traitement précis en guise de statistiques descriptives.
65 à 73	Nombre de traitements (1 à 9)	P	1	Cette variable contribuera à l'indice de sévérité développé.
74 à 82	Date de traitement (1 à 9)	P	4	Cette variable nous permettra de faire la distinction entre la sévérité de la maladie du patient et la possibilité d'une complication due aux soins dispensés. Certaines procédures clés effectuées au début du séjour à l'hôpital indiquent l'état grave du cas lors de son admission.
83	Date d'inscription à l'urgence	P	7	Cette variable contribuera à l'indice de sévérité du cas.

VARIABLE		GENRE	LONGUEUR	JUSTIFICATION
84 à 85	Code d'accident 2 à 3	P	5	Cette variable nous aidera à faire la distinction entre la sévérité du cas et une complication possible issue des soins dispensés.
86	Décès type	P	1	Cette variable nous permettra d'identifier de façon plus ponctuelle les décès, post-chirurgicaux ou autres.
87	Décès ± 48 heures	P	1	Cette variable nous permettra d'identifier de façon plus ponctuelle que les décès ayant lieu dans les vingt-quatre heures sont probablement dus à la sévérité des cas.
88	Date de sortie (AAMMJJ)	P	4	Cette variable nous permettra d'identifier les admissions consécutives de manière à construire nos épisodes de soins. Elle nous permettra aussi de contrôler l'effet de confusion résultant du temps écoulé lors de notre étude, du fait que les lignes directrices de la pratique clinique ont évolué au cours des dernières années. De plus, la date de sortie nous permettra de déterminer la durée de chaque séjour de même que la durée de chaque épisode de soins.
89	Jours de congé temporaires	P	3	Cette variable nous permettra de faire la distinction entre un congé précoce nécessitant une réadmission, et un congé planifié sous forme d'une sortie temporaire.
90	Séjour total	P	3	Cette variable nous permettra de tenir compte du fait que les patients qui demeurent à l'hôpital pour un séjour prolongé présentent plus de possibilités de décès au sein de l'établissement plutôt qu'ailleurs. Ce point a été relevé par plusieurs chercheurs qui ont critiqué des enquêtes précédentes qui n'ont pas tenu compte de ce point.
91	Type de destination	P	2	Cette variable permettra de mieux cerner le processus des soins au cours d'un épisode de soins comprenant une série d'hospitalisations.
92	Code de destination	P	5	Cette variable nous permettra d'identifier tous les séjours consécutifs et de déterminer si ceux-ci appartiennent au même épisode de soins ou pas. La variable contribuera également à définir le degré de sévérité de l'état de santé du patient, puisqu'il est concevable que les patients transférés des centres hospitaliers communautaires aux centres de soins spécialisés sont gravement malades. Enfin, le code de destination nous permettra de définir certains des attributs associés au transfert d'un patient, entre-autre, la distance.

VARIABLE		GENRE	LONGUEUR	JUSTIFICATION
93	RSS du bénéficiaire	X	2	RSS = Région Socio-sanitaire du bénéficiaire. Cette variable nous permettra de faire la distinction entre les résidents du Québec et d'autres patients. Cette étude vise uniquement les résidents du Québec. Cette variable nous permettra aussi d'attribuer au patient des caractéristiques écologiques supplémentaires, plus précisément la distance entre le CLSC du patient et le centre de santé le plus proche (des renseignements que nous avons à notre disposition mais qui dépendent de la disponibilité de la variable CLSC). Notons que la variable « CLSC » doit être utilisée en association avec la RSS et le DSC du bénéficiaire (REF : Dictionnaire de données : Clientèle hospitalière; Med-Écho version 2.hlp)
94	DSC du bénéficiaire			DSC = Département de santé communautaire Cette variable nous permettra d'attribuer au patient des caractéristiques écologiques supplémentaires, plus précisément la distance entre le CLSC du patient et le centre de santé le plus proche (des renseignements que nous avons à notre disposition mais qui dépendent de la disponibilité de la variable CLSC). Notons que la variable « CLSC » doit être utilisée en association avec la RSS et le DSC du bénéficiaire (REF : Dictionnaire de données : Clientèle hospitalière; Med-Écho version 2.hlp)
95	CLSC du bénéficiaire			Cette variable nous permettra d'attribuer au patient des caractéristiques écologiques supplémentaires, plus précisément la distance entre le CLSC du patient et le centre de santé le plus proche (des renseignements que nous avons à notre disposition mais qui dépendent de la disponibilité de la variable CLSC). Notons que la variable « CLSC » doit être utilisée en association avec la RSS et le DSC du bénéficiaire (REF : Dictionnaire de données : Clientèle hospitalière; Med-Écho version 2.hlp)

Annexe 3b

VARIABLES SUR LES SOINS HOSPITALIERS POUR LE PROJET :

L'Évaluation de la performance des hôpitaux :

Une étude méthodologique de l'impact du profile d'admission et des transferts sur le taux de mortalité inter-hospitalier.

SOURCE: BANQUE « STATISTIQUES DÉMOGRAPHIQUES » K29 - DÉCÈS (MSSS)

	VARIABLE	GENRE	LONGUEUR	JUSTIFICATION
1	Matricule du patient (brouillé)	AN	12	Ce numéro d'identification unique servira à rattacher les séjours consécutifs ce qui permettra de construire les épisodes de soins. On définit un épisode de soins comme une série de séjours consécutifs ayant moins de 30 jours entre la date de sortie d'un séjour hospitalier et la date d'admission de la prochaine hospitalisation. Notons que le matricule du patient est la variable que nous utiliserons pour fusionner les deux bases de données nécessaires, celle de MedÉcho et celle de la banque de données « Statistiques démographiques » pour les décès.
2	Date du décès	N	6	Le résultat que nous allons mesurer est le décès dans les trente (30), soixante (60) quatre-vingt-dix (90) jours ou plus suite au dernier congé d'un épisode de soins. La date de décès est nécessaire afin de pouvoir définir cette variable. De plus, nous allons faire une analyse de survie et aurons donc besoin de la date de décès afin de pouvoir identifier les observations censurées (c'est à dire qu'un patient ne fait plus partie de la cohorte suite à son décès dû à une autre maladie)
3	code d'établissement	X	8	Cette variable indique le lieu du décès : dans un hôpital, à domicile, ailleurs qu'à l'hôpital ou à domicile ou hors du Québec. Cette variable nous permettra de déterminer si le patient est retourné dans le système de santé suite à l'admission originale et avant le décès. Nous serons également en mesure d'associer les attributs pertinents à l'établissement où le décès a eu lieu.
4	Cause médicale du décès	AN	4	Cette variable nous permettra de faire la distinction entre les décès associés à l'infarctus du myocarde (le résultat sous étude) et ceux qui ne le sont pas (les observations censurées). Puisque nous allons faire une analyse de survie, nous aurons besoin de la cause de décès pour pouvoir identifier les observations censurées (c'est à dire qu'un patient ne fait plus partie de la cohorte suite à son décès dû à une autre maladie)

Titre de l'étude :
L'Évaluation de la performance des hôpitaux : une étude méthodologique de l'impact du profil d'admission et des transferts sur le taux de mortalité inter-hospitalier.

N/Réf. (CAI) : 02 04 58

Demande de données

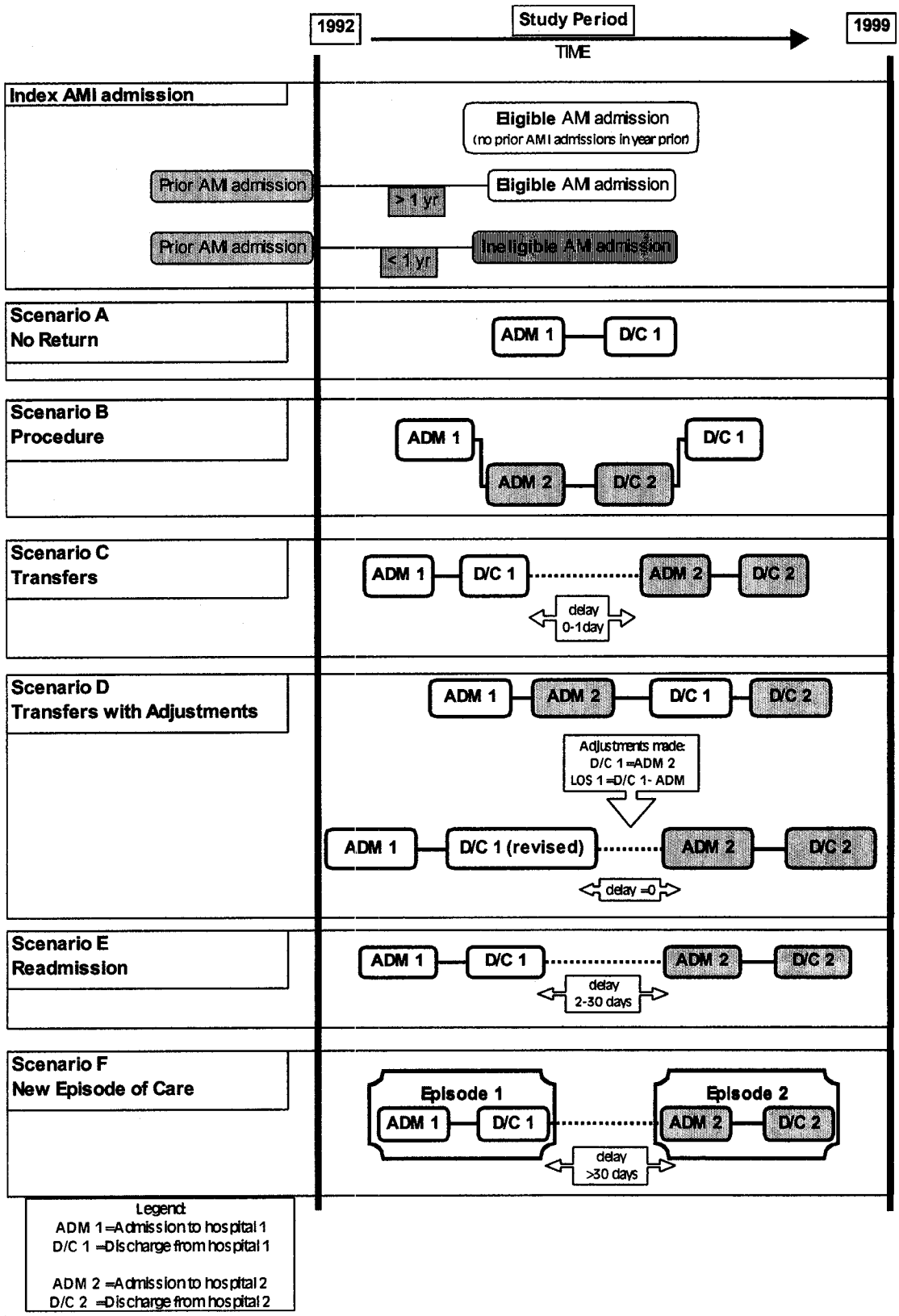
Étapes

1) Pour les années 1992 à 1999 prendre tous les hospitalisation dont le diagnostique principal est 410 (les 3 premier caractères).
2) Enlever les observations pour les personnes qui ont moins de 18 ans
3) Enlever les patients qui ne sont pas résident du Québec.
4) Enlever les observations pour les numéros d'hôpital suivant

```
hospno='11042215'or     /*louis h. lafontaine-psych*/
hospno='11230711'or     /*NID ch guy laporte-private plastic*/
hospno='11269552'or     /*hop marie-enfant-peds rehab*/
hospno='11888062'or     /*ch robert giffard-psych*/
hospno='12375143'or     /*NID sanatorium begin-psych*/
hospno='12461570'or     /*mtl children's*/
hospno='12576138'or     /*ch courchesne- became clsc-ch but no beds,
outpt*/
hospno='12679809'or     /*NID ch pierre janet-acute psych*/
hospno='12694659'or     /*hop ste justine*/
hospno='12722070'or     /*NID ch malartic-became psych,was acute*/
hospno='12811279'or     /*institut roland saucier-psych*/
hospno='12830162'or     /*NID clinique roy rousseau-psych*/
hospno='12840286'or     /*NID ch sainte therese de shawinigan-psych*/
hospno='13391024'or     /*NID le claire fontaine-integration sociale*/
hospno='13506472'or     /*NID shriners-peds*/
hospno='13727060'or     /*douglas hospital-psych*/
hospno='13727086'or     /*NID hd du sacre coeur de jesus de quebec -
psych*/
```

5) Lorsque toutes les observations non désirées sont enlevées, ne garder que la première hospitalisation (la plus ancienne). Donc nous ne voulons qu'une seule observation par patient, celle qui est la plus ancienne.
6) Prendre cette observation par patient et garder la date d'admission pour calculer la date un an avant la date d'admission. Appelons cette dernière date de début.
7) Pour l'ensemble de ces patients nous désirons toutes les hospitalisations à partir de la date de début (un an avant la date d'admission retenu au point 5) jusqu'à 2000.

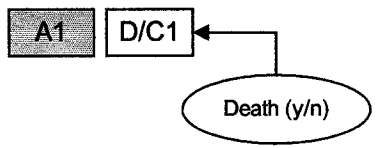
Appendix 6: Algorithms used to construct episodes of care



Appendix 7: Assigning outcome and exposure values, 3 ways to define outcomes

Exposure	Outcome		
exposure choice	**outcome choice**	**outcome values**	**conditions to meet**
1st AMI episode exclude transfers	inhos_dth* (in-hospital death)	1	death1 = 1
		0	death1 = 0
admno = 1	7d_dth** (death within 7d of AMI)	1	(datdth-datfadm) LE 7
hos1 where trout1 OR prout1 = "0	30d_dth** (death within 30d of AMI)	1	(datdth-datfadm) LE 30
		0	(datdth-datfadm) > 30

Hospital to which outcome is assigned



always assign to initial hospital

Legend:
A 1 = Admission to hospital 1
D/C 1 = Discharge from hospital 1
Death = Death (in-hospital, at 7 days, at 30 days

* these values are based on information obtained from MedEcho database
** these values are based on information obtained from death certificates

admno = admission number for a given patient, in chronological order. The first admission represents the index AMI admission.

hos1 = first hospital patient was admitted to (index admission)

trout1 = transfer status at end of the index admission (value "0" indicates patient was not transferred)

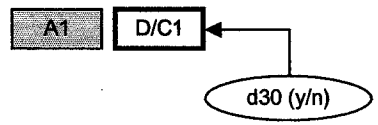
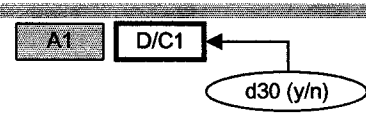
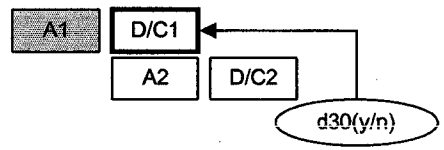
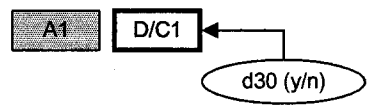
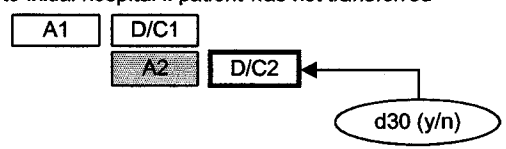
prout1 = status re: being sent out for a procedure during the index admission
(value "0" indicates patient was not sent out for a procedure during the index admission)

death1 = outcome of index admission
(value "1" indicates patient died in hospital; value "0" indicates patient was discharged alive)

datdth = date of death (obtained from death certificates)

datfadm = date of 1st AMI (index) admission

Appendix 8: Assigning outcome and exposure values; 3 ways to handle transfers

Exposure	Outcome			
exposure choice	**outcome choice**	**outcome values**	**conditions to meet**	**Hospital to which outcome is assigned**
1st AMI episode exclude transfers admno = 1 hos1 where trout1 OR prout1 = "0"	death within 30 days of AMI**	1 0	(datdth-datfadm) LE 30 (datdth-datfadm) > 30	
1st AMI episode include transfers attribute to hos1 admno = 1 and hos1 where trout1 OR prout1 = "0" and hos1 where trout1 OR prout ="1"	death within 30 days of AMI**	1 0	(datdth-datfadm) LE 30 (datdth-datfadm) > 30	  always assign to initial hospital
1st AMI episode include transfers attribute to hos1 or hos2 admno = 1 and admno = 2 and hos1 where trout1 OR prout1 = "0" and hos2 where trin2 OR prin2 = "1"	death within 30 days of AMI**	1 0	(datdth-datfadm) LE 30 (datdth-datfadm) > 30	 assign to initial hospital if patient was not transferred  assign to receiving hospital if patient was transferred

** these values are based on information obtained from death certificates

Legend:
ADM 1 = Admission to hospital 1
D/C 1 = Discharge from hospital 1
ADM 2 = Admission to hospital 2
D/C 2 = Discharge from hospital 2
d30 = Dead or alive at discharge

admno = admission number in chronological order. The first admission represents the index AMI admission.
hos1 = first hospital patiet was admitted to (index admission)
hos2 = second hospital patiet was admitted to
trout1 = transfer status at end of index admission (value "0" indicates patient was not transferred)
trin2 = transfer status at beginning of 2nd admission
prout1 = status re: being sent out for a procedure during index admission. (value "0" indicates patient was not sent out for a procedure)
prin2 = status re: being brought in for a procedure during 2nd admission (value "1" indicates patient was brought in for a procedure)
**datdth = date of death (obtained from death certificates)
datfadm = date of 1st AMI (index) admission

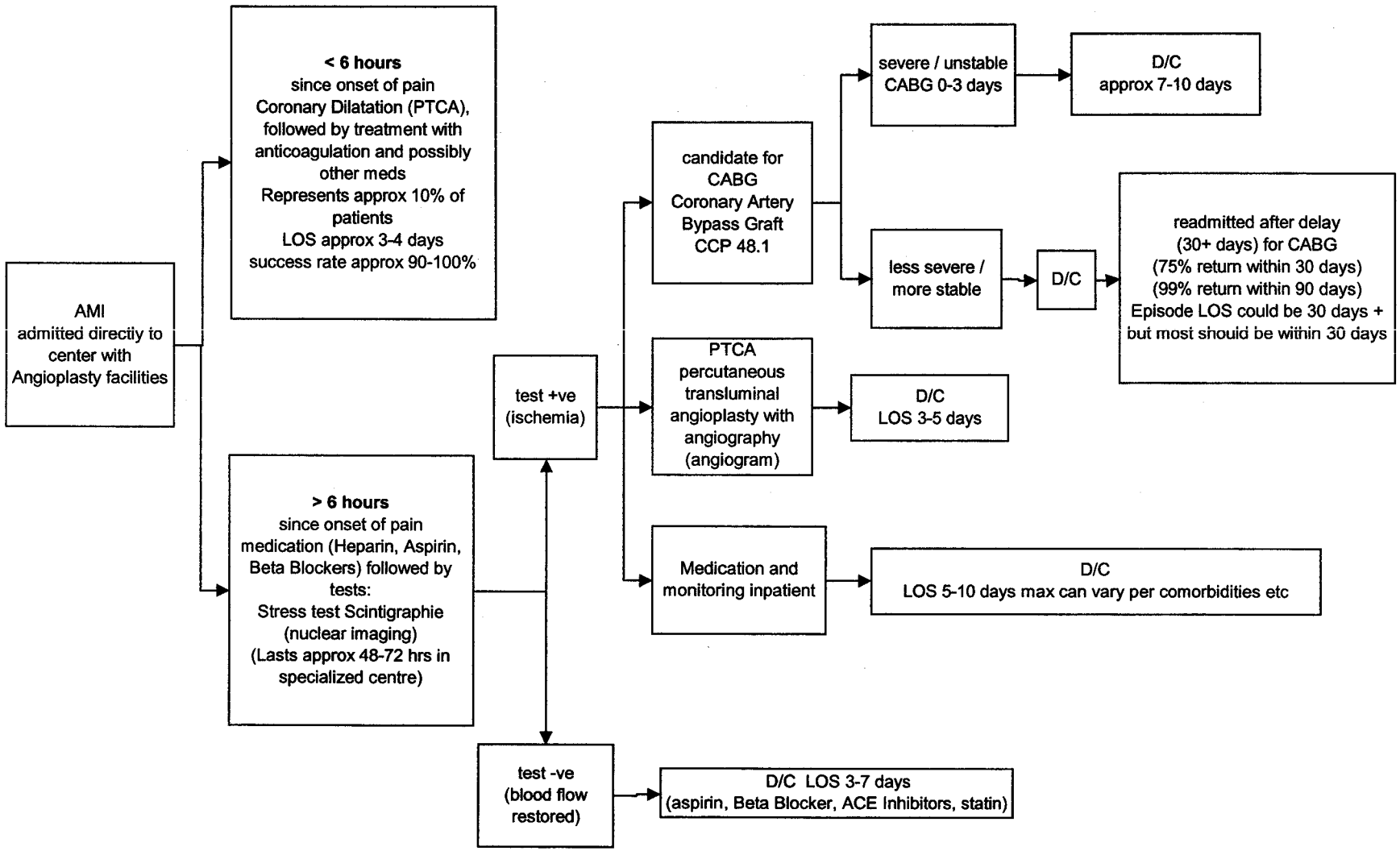
Appendix 9: Dartmouth-Manitoba adaptation of the Charlson Co-morbidity Index

Comorbidity Diagnosis	Weight	Romano-Roos
Myocardial infarction	1	410 to 410.9, 412
Congestive heart failure	1	402.0, 402.1, 402.9, 425, 428 to 428.9, 429.3
Peripheral vascular disease	1	440.x, 441.x, 442.x, 443.1 to 443.9, 447.1, 785.4
Cerebrovascular disease	1	362.3, 430-436, 437-437.1, 437.9, 438, 781.4, 784.3, 997.0
Dementia	1	290.x, 331 - 331.2
Chronic pulmonary disease	1	415.0, 416.8 - 416.9, 491.x - 494, 496
Rheumatologic or Connective Tissue Disease	1	710.x, 714.x
Peptic ulcer disease	1	531.x - 534.x
Mild liver disease	1*	571.2, 571.5 - 571.6, 571.8 -571.9
Diabetes (Mild to moderate)	1	250.0 - 250.3
Diabetes with chronic complications	2	250.4 to 250.9 §
Hemiplegia or Paraplegia	2	342.x, 344.x
Renal disease	2	585 – 586, V42.0, V45.1, V56.x
Malignancy, including Lymphoma & Leukemia	2*	140.x – 171.x , 174.x - 195.x , 200.x - 208.x , 273.0, 273.3, v10.46
Moderate or Severe Liver Disease §	3	456.0 to 456.2, 572.2 to 572.4
Metastatic solid tumour §	6	196 to 199
Aids	6	042 to 044

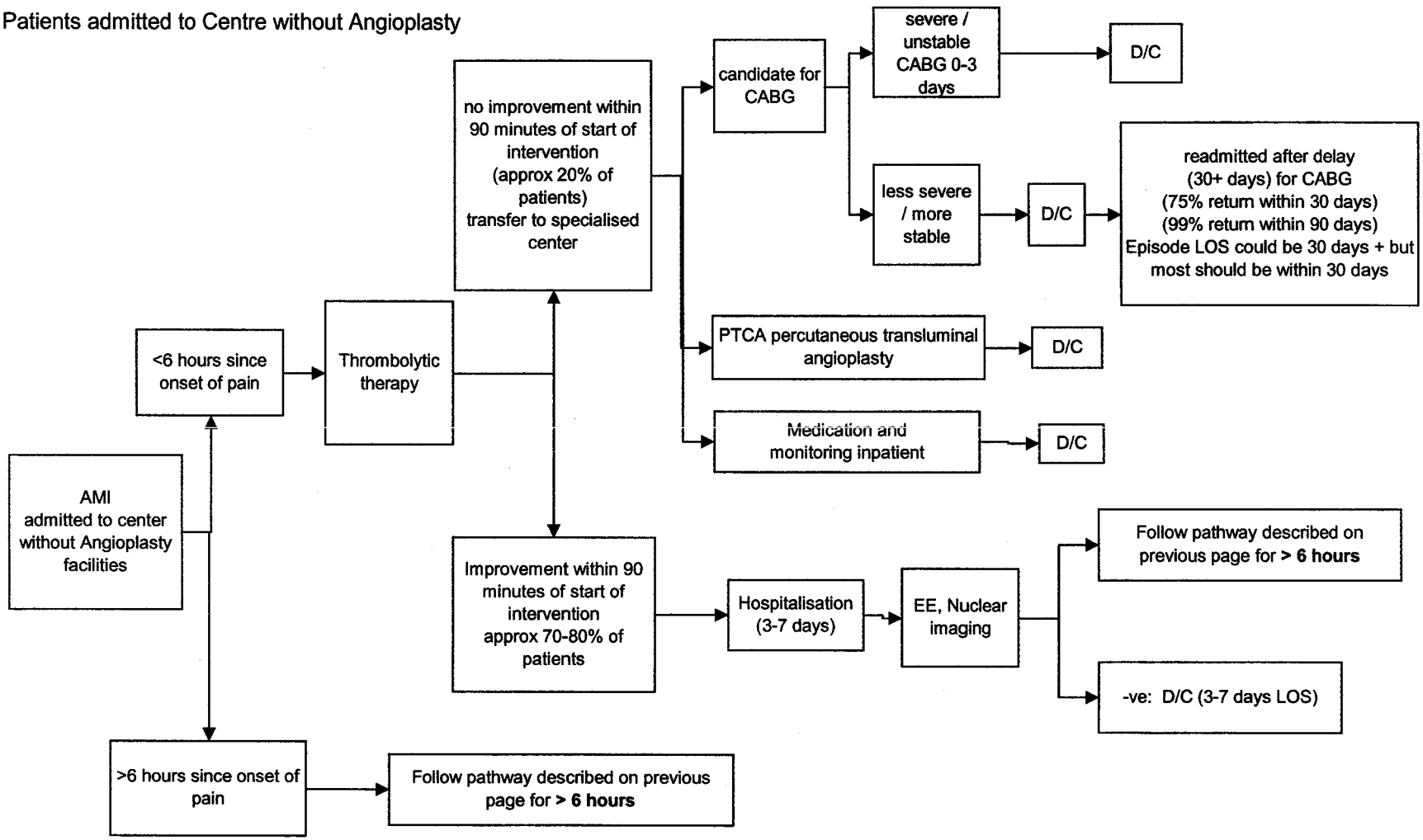
§ In the Dartmouth-Manitoba algorithm, these comorbidities take precedence over less severe comorbidities involving the same organ system. For example, a patient with metastatic solid tumor would have that comorbidity coded as present and any associated primary malignancy diagnoses would be ignored. Moderate-to-severe liver disease and complicated diabetes are treated in the same way, to avoid inadvertently double-counting one chronic condition that may be characterized using multiple diagnosis codes in administrative data.

Appendix 10: Patterns of AMI care in Quebec

Patients admitted to Centre with Angioplasty



Patients admitted to Centre without Angioplasty



Sources:

Dr. Xavier Ranouil, personal communication July 26, 2002; Dr. James Brophy, personal communication October 3, 2003; Ryan TJ, Antman EM, Brooks NH, Calliff RM, Hillis LD, Hiratzka LF et al. ACC/AHA guidelines for the management of patients with acute myocardial infarction: 1999 update: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Management of Acute Myocardial Infarction). 1999.

Appendix 11a: Computing Distance to nearest tertiary care centre using Patients' CLSC codes

Number of admissions in dataset where:

	CLSC codes matched to MapQuest	Old CLSC codes matched to new CLSC codes	**Missing data:** Distance to tertiary centre imputed n (%)		Total admissions in dataset
include transfers	61,762	29,652	219	0.24%	91,633
Exclude transfers	52,706	25,204	203	0.26%	78,113

Appendix 11b: CLSC postal codes and distance to nearest tertiary care centre

	CLSC code	# patients NOTRF (n , %)		# patients WTRF (n , %)		postal code	Visual Estimate	Bird's Flight	min dist to tertiary hos
	1101	561	0.72%	645	0.70%	G5L 7R2			276.06
	1102	267	0.34%	301	0.33%	G5H 3L6			305.05
	1103	270	0.35%	347	0.38%	G4W 3A8			361.24
	1105	285	0.36%	350	0.38%	G0J 1J0			387.58
	1301	148	0.19%	185	0.20%	G0L 4K0			211.66
	1302	86	0.11%	110	0.12%	G0L 1X0			260.66
	1303	407	0.52%	482	0.53%	G5R 4W5			168.53
	1304	268	0.34%	335	0.37%	G0L 3Y0			159.78
	1305	181	0.23%	214	0.23%	G0L 1X0			260.66
	2100	5	0.01%	5	0.01%				
	2101	114	0.15%	119	0.13%	G7B 3P9	x		19
	2102	319	0.41%	325	0.35%	G7H 7Z5	x		1
	2103	885	1.13%	1,016	1.11%	G7X 7X2	x		119.41
	2106	673	0.86%	684	0.75%	G7H 7Z5	x		1
	2202	357	0.46%	484	0.53%	G8K 2P8	x		120
	2203	318	0.41%	406	0.44%	G8L 5K6	x		119.41
	2204	574	0.73%	693	0.76%	G8B 7A6	x		38
	3000	235	0.30%	265	0.29%	G0A 4B0			71.73
	3101	136	0.17%	145	0.16%	G1X 1P8			1.22
	3102	311	0.40%	338	0.37%	G1X 1P8			1.22
	3201	187	0.24%	210	0.23%	G1N 2W1			3.02
	3202	134	0.17%	162	0.18%	G1K 5N1			1.92
	3203	281	0.36%	360	0.39%	G1K 5N1			1.92
	3204	138	0.18%	159	0.17%	G1N 2W1			3.02
	3300	228	0.29%	253	0.28%	G2A 2T7			14.93
	3301	684	0.88%	796	0.87%				
	3302	564	0.72%	667	0.73%				
	3304	146	0.19%	173	0.19%				
	3305	262	0.34%	298	0.33%				
	3306	117	0.15%	130	0.14%				
	3401	237	0.30%	328	0.36%	G0A 1E0			52.08
	3402	100	0.13%	133	0.15%	G0A 1E0			52.08
	3500	284	0.36%	367	0.40%	G1H 7K4			7.6
	3501	387	0.50%	446	0.49%				
	3505	269	0.34%	310	0.34%				
	3506	460	0.59%	535	0.58%				
	3508	542	0.69%	596	0.65%				
	3601	303	0.39%	335	0.37%				
	3602	305	0.39%	342	0.37%				
	3603	569	0.73%	641	0.70%				
	3605	299	0.38%	357	0.39%				
	3701	55	0.07%	72	0.08%	G5A 1S8			144.16
	3702	45	0.06%	59	0.06%	G5A 1S8			144.16
	4101	149	0.19%	196	0.21%				
	4102	184	0.24%	212	0.23%				
	4103	983	1.26%	1,169	1.28%				
	4202	1,088	1.39%	1,275	1.39%				

Appendix 11b: CLSC postal codes and distance to nearest tertiary care centre

	CLSC code	# patients NOTRF (n , %)		# patients WTRF (n , %)		postal code	Visual Estimate	Bird's Flight	min dist to tertiary hos
	4203	602	0.77%	804	0.88%				
	4204	235	0.30%	301	0.33%				
	4301	311	0.40%	415	0.45%				
	4302	792	1.01%	1,063	1.16%				
	4303	144	0.18%	182	0.20%				
	4304	253	0.32%	307	0.34%				
	4305	514	0.66%	645	0.70%				
	4306	192	0.25%	249	0.27%				
	5100	10	0.01%	10	0.01%				
	5101	249	0.32%	328	0.36%	G6B 1A5			104.65
	5102	193	0.25%	224	0.24%	J1T 1X6			68.53
	5103	251	0.32%	288	0.31%	J0B 3J0			53.5
	5104	341	0.44%	379	0.41%	J1S 2P8			29.68
	5105	168	0.22%	195	0.21%	J1A 1W3			40.77
	5106	468	0.60%	632	0.69%	J1X 3X3			30.98
	5107	624	0.80%	744	0.81%	J1H 4J5			1.34
	5108	867	1.11%	1,023	1.12%	J1H 4J5			1.34
	6000	119	0.15%	130	0.14%				
	6101	495	0.63%	614	0.67%	H9S 4S1			20.88
	6103	524	0.67%	641	0.70%	H8Z 3H6			12.56
	6104	254	0.33%	325	0.35%	H8Z 3H6			12.56
	6105	700	0.90%	846	0.92%	H8S 2G2			13.66
	6201	209	0.27%	232	0.25%	H3K 2R4			4.42
	6202	869	1.11%	994	1.08%	H4G 2M4			5.24
	6204	496	0.63%	564	0.62%	H4G 2M4			5.24
	6206	850	1.09%	1,033	1.13%	H8P 3N4			13.3
	6301	365	0.47%	414	0.45%	H1E 4M7			12.02
	6302	642	0.82%	736	0.80%	H1A 1T5			14.51
	6303	557	0.71%	637	0.70%	H1L 6P2			5.64
	6304	551	0.71%	634	0.69%	H1N 1B2			1.5
	6305	635	0.81%	678	0.74%	H1V 1K2			3.98
	6306	1,086	1.39%	1,184	1.29%	H1X 1W3			3.28
	6308	425	0.54%	481	0.52%	H1L 6P2			5.64
	6309	722	0.92%	810	0.88%	H1P 1T9			2.46
	6401	466	0.60%	508	0.55%	H3T 2A8			0.16
	6402	409	0.52%	433	0.47%	H3T 2A8			0.16
	6403	831	1.06%	863	0.94%	H4W 2T5			4.59
	6404	357	0.46%	383	0.42%	H3T 2A8			0.16
	6501	698	0.89%	752	0.82%	H4B 2Y4			5.99
	6503	465	0.60%	492	0.54%	H3H 1J9			1.64
	6504	277	0.35%	286	0.31%	H2T 1H4			1.77
	6505	289	0.37%	317	0.35%	H4C 1P8			3.28
	6600	12	0.02%	13	0.01%				
	6601	1,108	1.42%	1,240	1.35%	H1G 4J9			6.04
	6603	479	0.61%	551	0.60%	H1Z 3E1			3.14
	6605	893	1.14%	1,012	1.10%	H2C 3K2			5.92
	6606	565	0.72%	586	0.64%	H3L 1K5			2.89

Appendix 11b: CLSC postal codes and distance to nearest tertiary care centre

	CLSC code	# patients NOTRF (n , %)		# patients WTRF (n , %)		postal code	Visual Estimate	Bird's Flight	min dist to tertiary hos
	6608	811	1.04%	857	0.94%	H4L 3Z2			3.65
	6701	458	0.59%	474	0.52%	H2L 3C3			1.06
	6702	503	0.64%	522	0.57%	H2H 1V4			1.36
	6704	207	0.27%	222	0.24%	H3N 1R4			4.6
	6705	129	0.17%	133	0.15%	H2L 3C3			1.06
	6706	706	0.90%	775	0.85%	H2E 1A7			4.54
	6707	555	0.71%	596	0.65%	H2S 2P7			4.72
	7100	9	0.01%	9	0.01%				
	7101	517	0.66%	521	0.57%				
	7102	191	0.24%	193	0.21%				
	7103	326	0.42%	328	0.36%				
	7104	162	0.21%	176	0.19%				
	7105	225	0.29%	235	0.26%				
	7106	94	0.12%	102	0.11%				
	7107	98	0.13%	103	0.11%				
	7109	363	0.46%	366	0.40%				
	7110	233	0.30%	240	0.26%				
	7201	278	0.36%	282	0.31%	J8X 4E6			4.2
	7202	100	0.13%	104	0.11%	J9H 6N8			12.1
	7300	281	0.36%	333	0.36%	J8T 4J3			8.86
	7400	68	0.09%	84	0.09%	J0X 1V0			106.3
	7500	55	0.07%	73	0.08%	J0X 2W0			29.68
	7600	103	0.13%	133	0.15%	J9E 2E7			119.08
	7701	140	0.18%	158	0.17%	J8L 2W1			33.07
	7702	91	0.12%	109	0.12%	J0V 1W0			73.15
	8101	23	0.03%	24	0.03%	J0Z 3R0			409.87
	8102	156	0.20%	194	0.21%	J0Z 3W0			486.61
	8103	360	0.46%	506	0.55%	J9X 2A9			489.06
	8104	244	0.31%	289	0.32%	J9Z 2X7			562.95
	8105	287	0.37%	322	0.35%	J9T 4L3			455.67
	8106	531	0.68%	604	0.66%	J9P 5H3			391.6
	9101	67	0.09%	89	0.10%	G0T 1K0			132.25
	9102	69	0.09%	104	0.11%	G0T 1K0			132.25
	9103	312	0.40%	423	0.46%	G5C 1Z9			260.97
	9105	65	0.08%	111	0.12%	G4R 2W9			466.65
	9106	175	0.22%	288	0.31%	G4R 2W9			466.65
	9107	22	0.03%	26	0.03%	G0G 1J0			751.55
	9109	60	0.08%	90	0.10%	G0G 1P0			673.59
	9110	36	0.05%	55	0.06%	G0G 1W0			1933.67
	10101	64	0.08%	93	0.10%	G8P 3A7			355.67
	10102	20	0.03%	27	0.03%	G8P 3A7			355.67
	10103	14	0.02%	16	0.02%	G8P 3A7			355.67
	10104	9	0.01%	13	0.01%	G8P 3A7			355.67
	11201	304	0.39%	395	0.43%	G0C 2K0			645.04
	11203	341	0.44%	400	0.44%	G0C 1K0			710.23
	11204	240	0.31%	261	0.28%	G4X 2R8			656.35
	11205	46	0.06%	55	0.06%	G4X 2R8			656.35

Appendix 11b: CLSC postal codes and distance to nearest tertiary care centre

	CLSC code	# patients NOTRF (n , %)		# patients WTRF (n , %)		postal code	Visual Estimate	Bird's Flight	min dist to tertiary hos
	11206	169	0.22%	205	0.22%	G0B 1B0	x	x	700
	11207	6	0.01%	7	0.01%	G4X 2R8			656.35
	11208	252	0.32%	295	0.32%	G4V 1X4			476.92
	11209	125	0.16%	153	0.17%	G0J 1V0			474.95
	12101	259	0.33%	322	0.35%	G0R 1S0	x		100
	12102	257	0.33%	321	0.35%	G6E 3C6			43.72
	12103	525	0.67%	700	0.76%	G0M 1G0			124.05
	12104	239	0.31%	327	0.36%	G0S 2V0			63.01
	12105	582	0.75%	687	0.75%	G6G 1J1			98.81
	12401	519	0.66%	674	0.74%	G6V 4P6			22.75
	12402	515	0.66%	621	0.68%	G6X 1L6			10.71
	12403	350	0.45%	423	0.46%	G0R 3J0	x		100
	12404	303	0.39%	348	0.38%	G0S 1N0			38.94
	12701	180	0.23%	214	0.23%				
	12702	31	0.04%	36	0.04%	G0R 3G0			108.05
	12703	104	0.13%	139	0.15%				
	12704	354	0.45%	434	0.47%	G0R 2J0	x		100
	13800	30	0.04%	33	0.04%				
	13801	517	0.66%	651	0.71%	H7C 1M9			9.07
	13803	1,016	1.30%	1,116	1.22%	H7X 1J4			3.91
	13805	920	1.18%	1,121	1.22%	H7N 5S5			6.62
	13807	793	1.02%	961	1.05%	H7L 4L2			13.87
	14201	478	0.61%	611	0.67%	J0K 2J0			69.04
	14202	535	0.68%	681	0.74%	J0K 3K0	x		75
	14203	679	0.87%	834	0.91%	J6E 8S8			70.85
	14204	463	0.59%	565	0.62%	J0K 2L0			49.39
	14205	829	1.06%	1,034	1.13%	J6W 5B1			23.15
	14206	966	1.24%	1,143	1.25%	J5W 1S7			37.72
	15101	787	1.01%	953	1.04%	J7R 1K6			28.18
	15102	866	1.11%	1,003	1.09%	J7E 4Y5			19.64
	15103	452	0.58%	530	0.58%	J9L 1K8			204.82
	15104	1,073	1.37%	1,182	1.29%	J7Z 5L3			49.45
	15105	359	0.46%	411	0.45%	J8B 2N5			64.19
	15106	454	0.58%	537	0.59%	J8E 3H9			112.39
	15107	402	0.51%	498	0.54%	J8H 4E9			65.05
	16001	58	0.07%	79	0.09%	J7V 7H4			38.03
	16002	44	0.06%	49	0.05%	J0S 1H0			73.53
	16003	78	0.10%	99	0.11%	J6S 3V4			71.1
	16004	46	0.06%	68	0.07%	J6K 1C7			21.57
	16005	23	0.03%	25	0.03%	J0L 2L0			32.32
	16006	51	0.07%	76	0.08%	J5R 1C1			20.29
	16007	96	0.12%	113	0.12%	J4Z 1A5			10.04
	16008	85	0.11%	97	0.11%	J4J 2G4			3.18
	16009	47	0.06%	54	0.06%	J4J 1T2			2.81
	16010	72	0.09%	85	0.09%	J3Y 8Z4			5.62
	16011	71	0.09%	84	0.09%	J4B 6S2			9.43
	16012	110	0.14%	139	0.15%	J2X 3W9			44.89

Appendix 11b: CLSC postal codes and distance to nearest tertiary care centre

	CLSC code	# patients NOTRF (n , %)		# patients WTRF (n , %)		postal code	Visual Estimate	Bird's Flight	min dist to tertiary hos
	16013	74	0.09%	93	0.10%	J3G 5S8			32.27
	16014	40	0.05%	52	0.06%	J3L 5R6			25.16
	16015	59	0.08%	68	0.07%	J3P 3N7			68.44
	16016	75	0.10%	86	0.09%	J2S 8H1			45
	16017	55	0.07%	67	0.07%	J0J 1A0			79.54
	16018	97	0.12%	117	0.13%	J2G 5K9			83.42
	16019	16	0.02%	24	0.03%	J0H 1A0			111.13
	16101	572	0.73%	726	0.79%				
	16102	348	0.45%	387	0.42%				
	16103	693	0.89%	860	0.94%				
	16104	794	1.02%	937	1.02%				
	16201	665	0.85%	737	0.80%				
	16203	835	1.07%	1,013	1.11%				
	16204	847	1.08%	1,025	1.12%				
	16205	189	0.24%	222	0.24%				
	16206	855	1.09%	976	1.07%				
	16300	18	0.02%	19	0.02%				
	16301	656	0.84%	785	0.86%				
	16304	1,002	1.28%	1,145	1.25%				
	16305	578	0.74%	727	0.79%				
	16306	680	0.87%	800	0.87%				
	16307	556	0.71%	663	0.72%				
	16308	756	0.97%	882	0.96%				
	16401	617	0.79%	700	0.76%				
	16402	332	0.43%	390	0.43%				
	16405	244	0.31%	298	0.33%				
	16406	1,138	1.46%	1,318	1.44%				
	17101	3	0.00%	5	0.01%	J0M 1P0	x		2500
	17102	6	0.01%	10	0.01%	J0M 1C0	x		2500
	18101	33	0.04%	42	0.05%	J0M 1E0			1242.26
Total:	218	78,113	100%	91,633	100%	156	14	1	

Appendix 11c: 62 CLSCs linked to new CLSC codes

imputed values

old CLSC code	# patients NOTRF (n , %)		# patients WTRF (n , %)		link to new CLSC code	postal code	min dist to tertiary hos	replace missing values with grand mean (175km)
2100	5	0.01%	5	0.01%	—	—	—	175
3301	684	0.88%	796	0.87%	3500	G1H 7K4	7.6	
3302	564	0.72%	667	0.73%	3401	G0A 1E0	52.08	
3304	146	0.19%	173	0.19%	3701	G5A 1S8	144.16	
3305	262	0.34%	298	0.33%	3402	G0A 1E0	52.08	
3306	117	0.15%	130	0.14%	3702	G5A 1S8	144.16	
3501	387	0.50%	446	0.49%	3000	G0A 4B0	71.73	
3505	269	0.34%	310	0.34%	3101	G1X 1P8	1.22	
3506	460	0.59%	535	0.58%	3300	G2A 2T7	14.93	
3508	542	0.69%	596	0.65%	3102	G1X 1P8	1.22	
3601	303	0.39%	335	0.37%	3201	G1N 2W1	3.02	
3602	305	0.39%	342	0.37%	3202	G1K 5N1	1.92	
3603	569	0.73%	641	0.70%	3203	G1K 5N1	1.92	
3605	299	0.38%	357	0.39%	3204	G1N 2W1	3.02	
4101	149	0.19%	196	0.21%	4401	G9X 3C1	266.86	
4102	184	0.24%	212	0.23%	4402	G0X 3H0	183.86	
4103	983	1.26%	1,169	1.28%	4403	G9N 8L2	164.76	
4202	1,088	1.39%	1,275	1.39%	4503	J2B 5L4	101.24	
4203	602	0.77%	804	0.88%	4504	G6P 9N2	158.23	
4204	235	0.30%	301	0.33%	4505	G6L 1P4	170.25	
4301	311	0.40%	415	0.45%	4404	J5V 2H8	102.93	
4302	792	1.01%	1,063	1.16%	4405	G9A 5L2	132.21	
4303	144	0.18%	182	0.20%	4406	J5V 2H8	102.93	
4304	253	0.32%	307	0.34%	4501	J3T 1S4	146.36	
4305	514	0.66%	645	0.70%	4407	G8T 3Z8	138.04	
4306	192	0.25%	249	0.27%	4502	G0S 1J0	77.7	
5100	10	0.01%	10	0.01%	—	—	—	175
6000	119	0.15%	130	0.14%	—	—	—	175
6600	12	0.02%	13	0.01%	—	—	—	175
7100	9	0.01%	9	0.01%	—	—	—	175
7101	517	0.66%	521	0.57%	7201	J8X 4E6	4.2	
7102	191	0.24%	193	0.21%	7202	J9H 6N8	12.1	
7103	326	0.42%	328	0.36%	7300	J8T 4J3	8.86	
7104	162	0.21%	176	0.19%	7600	J9E 2E7	119.08	
7105	225	0.29%	235	0.26%	7701	J8L 2W1	33.07	
7106	94	0.12%	102	0.11%	7500	J0X 2W0	29.68	
7107	98	0.13%	103	0.11%	7400	J0X 1V0	106.3	
7109	363	0.46%	366	0.40%	7300	J8T 4J3	8.86	
7110	233	0.30%	240	0.26%	7702	J0V 1W0	73.15	
12701	180	0.23%	214	0.23%	12702	G0R 3G0	108.05	
12703	104	0.13%	139	0.15%	12702	G0R 3G0	108.05	
13800	30	0.04%	33	0.04%	—	—	—	175
16101	572	0.73%	726	0.79%	16004	J6K 1C7	21.57	
16102	348	0.45%	387	0.42%	16002	J0S 1H0	73.53	
16103	693	0.89%	860	0.94%	16001	J7V 7H4	38.03	
16104	794	1.02%	937	1.02%	16003	J6S 3V4	71.1	
16201	665	0.85%	737	0.80%	16015	J3P 3N7	68.44	
16203	835	1.07%	1,013	1.11%	16016	J2S 8H1	45	
16204	847	1.08%	1,025	1.12%	16013	J3G 5S8	32.27	
16205	189	0.24%	222	0.24%	16019	J0H 1A0	111.13	
16206	855	1.09%	976	1.07%	16018	J2G 5K9	83.42	
16300	18	0.02%	19	0.02%	—	—	—	175
16301	656	0.84%	785	0.86%	16011	J4B 6S2	9.43	
16304	1,002	1.28%	1,145	1.25%	16007	J4Z 1A5	10.04	
16305	578	0.74%	727	0.79%	16006	J5R 1C1	20.29	
16306	680	0.87%	800	0.87%	16010	J3Y 8Z4	5.62	
16307	556	0.71%	663	0.72%	16009	J4J 1T2	2.81	
16308	756	0.97%	882	0.96%	16008	J4J 2G4	3.18	
16401	617	0.79%	700	0.76%	16017	J0J 1A0	79.54	
16402	332	0.43%	390	0.43%	16014	J3L 5R6	25.16	
16405	244	0.31%	298	0.33%	16005	J0L 2L0	32.32	
16406	1,138	1.46%	1,318	1.44%	16012	J2X 3W9	44.89	
Total: 62	25,407		29,871		62	62		7

Appendix 12: Réseau québécois de cardiologie tertiaire (RQCT)

Services offerts aux adultes

1. Bilan hémodynamique 2. Coronarographie 3. Angioplastie coronarienne 4. Chirurgie cardiaque	5. Électrophysiologie 6. Installation de stimulateurs 7. Installation de défibrillateurs 8. Transplantation cardiaque

	1	2	3	4	5	6	7	8
Établissements								
Région 02 :								
Centre hospitalier de la Sagamie	X	X	X	X		X		
Région 03 :								
Hôpital Laval	X	X	X	X	X	X	X	X
Centre hospitalier universitaire de Québec								
o Hôtel-Dieu de Québec	X	X	X			X		
Centre hospitalier de l'Université Laval	X	X	X			X		
Région 05 :								
Centre hospitalier universitaire de Sherbrooke	X	X	X	X		X		
Région 06 :								
Institut de cardiologie de Montréal	X	X	X	X	X	X	X	X
Centre hospitalier universitaire de Montréal								
o Hôpital Notre-Dame	X	X	X	X	X	X	X	X
o Hôpital Saint-Luc	X	X	X	X		X		
o Hôtel-Dieu	X	X	X	X		X		
Centre universitaire de santé McGill								
o Hôpital général de Montréal	X	X	X	X		X	X	
o Hôpital Royal Victoria	X	X	X	X		X	X	X
Hôpital général juif Sir Mortimer B. Davis	X	X	X	X		X		
Hôpital du Sacré-Cœur de Montréal	X	X	X	X	X	X	X	
Hôpital Maisonneuve-Rosemont	X	X	X			X		
Région 07 :								
Centre hospitalier des Vallées de l'Outaouais	X	X	X			X		
Région 16 :								
Hôpital Pierre-Boucher	X	X	X			X		

1. Bilan hémodynamique 2. Coronarographie 3. Angioplastie coronarienne 4. Chirurgie cardiaque	5. Électrophysiologie 6. Installation de stimulateurs 7. Installation de défibrillateurs 8. Transplantation cardiaque

Retour au menu

Appendix 13: Tertiary cardiac care centres in Quebec 1992-1999

Legend

Hosnam =	Hospital name
Yradm =	year patient admitted
Yrvcbg =	annual volume of CABGs performed in hospital
Yrvapl =	annual volume of PTCAs performed in hospital

Obs	hosnam	yradm	yrvcbg	yrvapl
1	chpiebou	92	0	0
2	chpiebou	93	0	0
3	chpiebou	94	0	0
4	chpiebou	95	0	0
5	chpiebou	96	0	0
6	chpiebou	97	0	0
7	chpiebou	98	0	0
8	chpiebou	99	0	79
9	chreouta	92	0	0
10	chreouta	93	0	0
11	chreouta	94	0	0
12	chreouta	95	0	0
13	chreouta	96	0	0
14	chreouta	97	0	114
15	chreouta	98	0	183
16	chreouta	99	0	250
17	chunilav	92	0	0
18	chunilav	93	0	0
19	chunilav	94	0	0
20	chunilav	95	0	0
21	chunilav	96	0	0
22	chunilav	97	0	0
23	chunilav	98	0	0
24	chunilav	99	0	0
25	chunsher	92	82	120
26	chunsher	93	124	140
27	chunsher	94	117	180
28	chunsher	95	67	226
29	chunsher	96	66	233
30	chunsher	97	64	229
31	chunsher	98	76	258
32	chunsher	99	101	283
33	hchicout	92	43	68
34	hchicout	93	59	90
35	hchicout	94	45	78
36	hchicout	95	53	96
37	hchicout	96	61	70
38	hchicout	97	42	111
39	hchicout	98	50	103
40	hchicout	99	50	157
41	hdmtl	92	109	97
42	hdmtl	93	146	136
43	hdmtl	94	173	153
44	hdmtl	95	129	141
45	hdmtl	96	84	113
46	hdmtl	97	119	126
47	hdmtl	98	91	131
48	hdmtl	99	106	114

tertiary cardiac care centres in Quebec 1992-1999

Obs	hosnam	yradm	yrvcbg	yrvapl
49	hdquebec	92	18	42
50	hdquebec	93	65	79
51	hdquebec	94	79	90
52	hdquebec	95	86	108
53	hdquebec	96	133	175
54	hdquebec	97	125	195
55	hdquebec	98	0	224
56	hdquebec	99	0	235
57	hlaval	92	107	232
58	hlaval	93	173	356
59	hlaval	94	197	433
60	hlaval	95	220	370
61	hlaval	96	255	372
62	hlaval	97	278	610
63	hlaval	98	351	605
64	hlaval	99	365	647
65	hmaisros	92	0	16
66	hmaisros	93	0	13
67	hmaisros	94	0	26
68	hmaisros	95	0	15
69	hmaisros	96	0	11
70	hmaisros	97	0	9
71	hmaisros	98	0	1
72	hmaisros	99	0	4
73	hsaccomt	92	75	111
74	hsaccomt	93	66	208
75	hsaccomt	94	89	211
76	hsaccomt	95	113	283
77	hsaccomt	96	103	376
78	hsaccomt	97	119	386
79	hsaccomt	98	127	431
80	hsaccomt	99	110	397
81	hstluc	92	0	56
82	hstluc	93	0	108
83	hstluc	94	27	153
84	hstluc	95	66	214
85	hstluc	96	59	156
86	hstluc	97	53	146
87	hstluc	98	67	200
88	hstluc	99	53	184
89	instcarm	92	235	346
90	instcarm	93	374	526
91	instcarm	94	485	602
92	instcarm	95	375	710
93	instcarm	96	290	673
94	instcarm	97	311	620
95	instcarm	98	347	751
96	instcarm	99	357	675

tertiary cardiac care centres in Quebec 1992-1999

Obs	hosnam	yradm	yrvcbg	yrvapl
97	jgh	92	63	63
98	jgh	93	74	54
99	jgh	94	55	52
100	jgh	95	45	48
101	jgh	96	50	84
102	jgh	97	78	103
103	jgh	98	94	117
104	jgh	99	110	87
105	mgh	92	96	39
106	mgh	93	89	52
107	mgh	94	78	79
108	mgh	95	104	167
109	mgh	96	124	160
110	mgh	97	123	202
111	mgh	98	107	218
112	mgh	99	107	288
113	notrdame	92	62	71
114	notrdame	93	106	120
115	notrdame	94	80	161
116	notrdame	95	93	199
117	notrdame	96	93	209
118	notrdame	97	103	222
119	notrdame	98	108	190
120	notrdame	99	123	222
121	rvh	92	112	89
122	rvh	93	120	134
123	rvh	94	129	143
124	rvh	95	104	176
125	rvh	96	91	194
126	rvh	97	172	246
127	rvh	98	153	238
128	rvh	99	160	322

Appendix 14: Dummy variables created for hospital revascularization facilities

	Hospital	CABG	PTCA	CABG_fac	PTCA_fac
"chplebou"	CH Pierre Boucher	0	0 (yradm=92-98) 1 (yradm=99)	0	0 (yradm=92-98) 1 (yradm=99)
"chreouta"	CH Outaouais	0	0 (yradm=92-96) 1 (yradm=97-99)	0	0 (yradm=92-96) 1 (yradm=97-99)
"chunilav"	CH Universitaire Laval*	0	0	0	0
"chunsher"	CH Universitaire Sherbrooke	1	1	1	0
"hchicout"	CH Chicoutimi (de la Sagamie)	1	1	1	0
"hdmtl"	Hôtel Dieu Mtl	1	1	1	0
"hdquebec"	Hôtel Dieu Québec	1 (yradm=92-97) 0 (yradm=98-99)	1	1 (yradm=92-97) 0 (yradm=98-99)	0 (yradm=92-97) 1 (yradm=98-99)
"hlaval"	Hôpital Laval	1	1	1	0
"hmaisros"	Maisonneuve-Rosemont	0	1	0	1
"hsaccomt"	Sacré-Cœur	1	1	1	0
"hstluc"	St-Luc	0 (yradm=92-93) 1 (yradm=94-99)	1	0 (yradm=92-93) 1 (yradm=94-99)	1 (yradm=92-93) 0 (yradm=94-99)
"instcarm"	Institut de cardiologie de Mtl	1	1	1	0
"jgh"	JGH	1	1	1	0
"mgh"	MGH	1	1	1	0
"notrdame"	Notre Dame	1	1	1	0
"rvh"	RVH	1	1	1	0

Dummy Variables created for the three categories of availability of revascularization facilities **:

	Variable name	
	ptca_fac	cabg_fac
no revascularization facility	0	0
PTCA facilities only	1	0
PTCA and CABG facilities	0	1

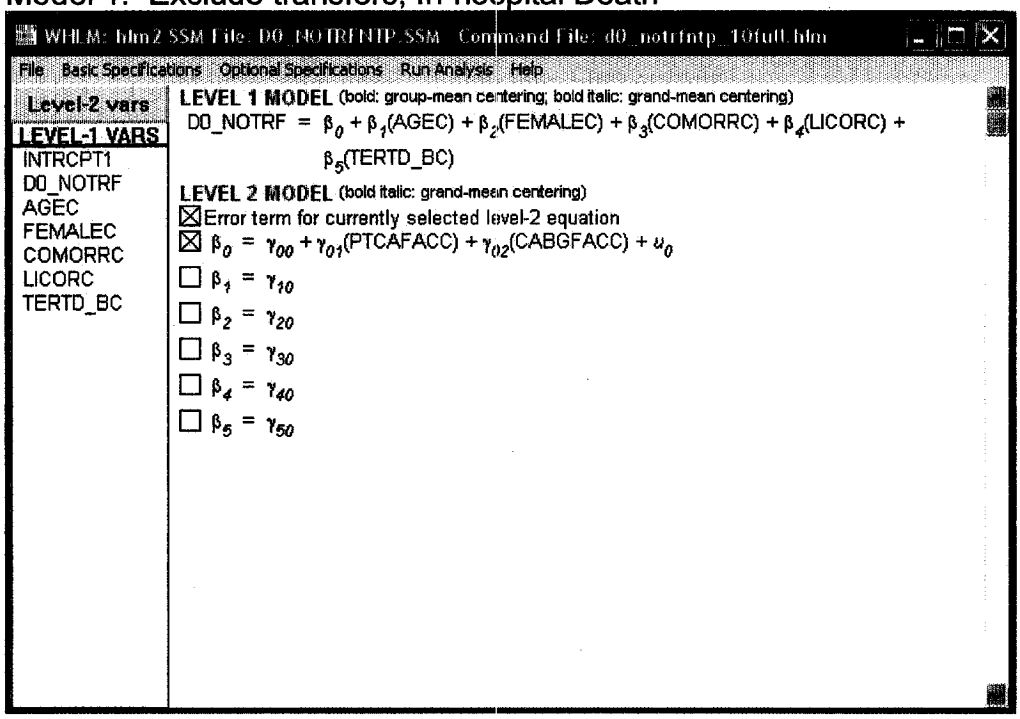
* no procedures done during study period, yet "chunilav" is included in tertiary care list

** hospitals in dataset that are not included in list above are not equipped with revascularization facilities.

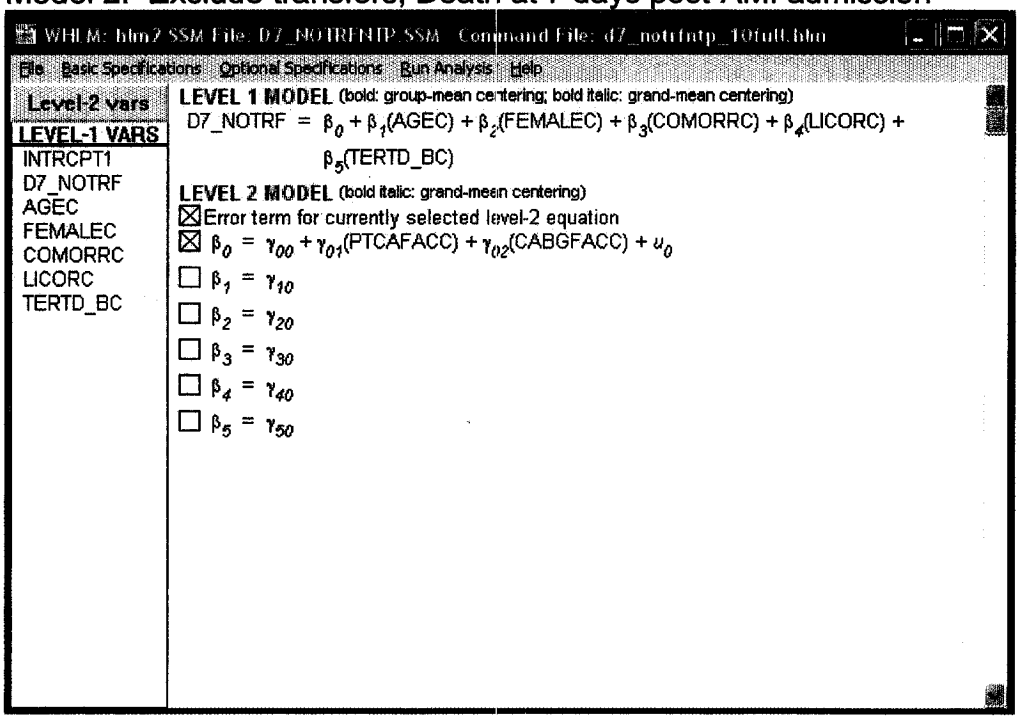
Appendix 15: HLM Models

Comparing Choice in Outcome Definition

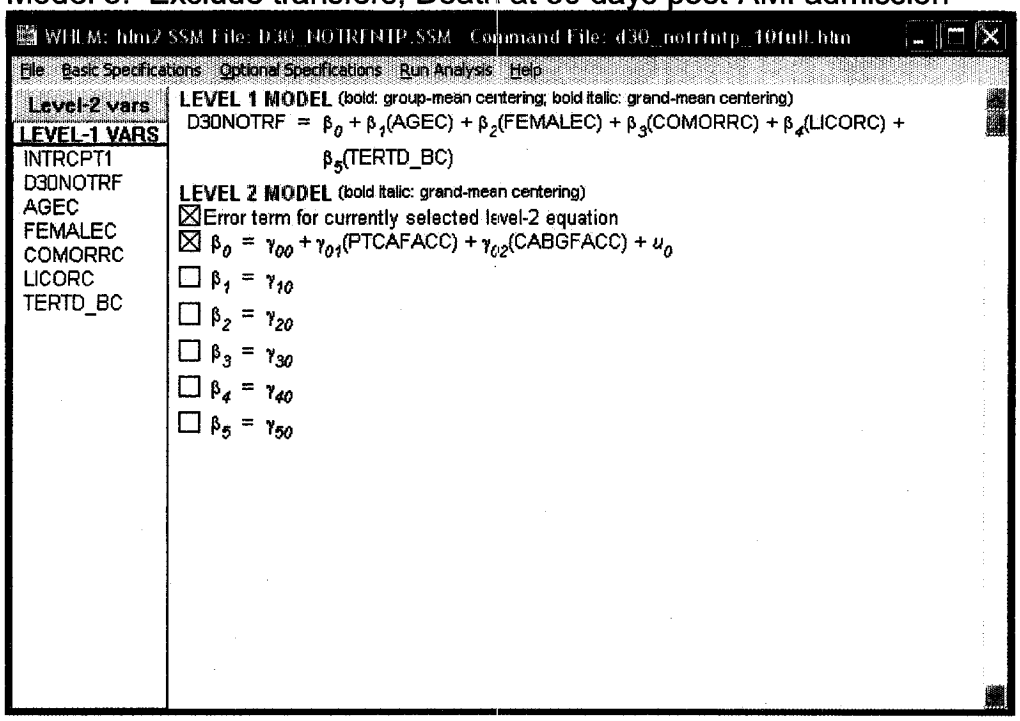
Model 1: Exclude transfers, In-hospital Death



Model 2: Exclude transfers, Death at 7 days post-AMI admission

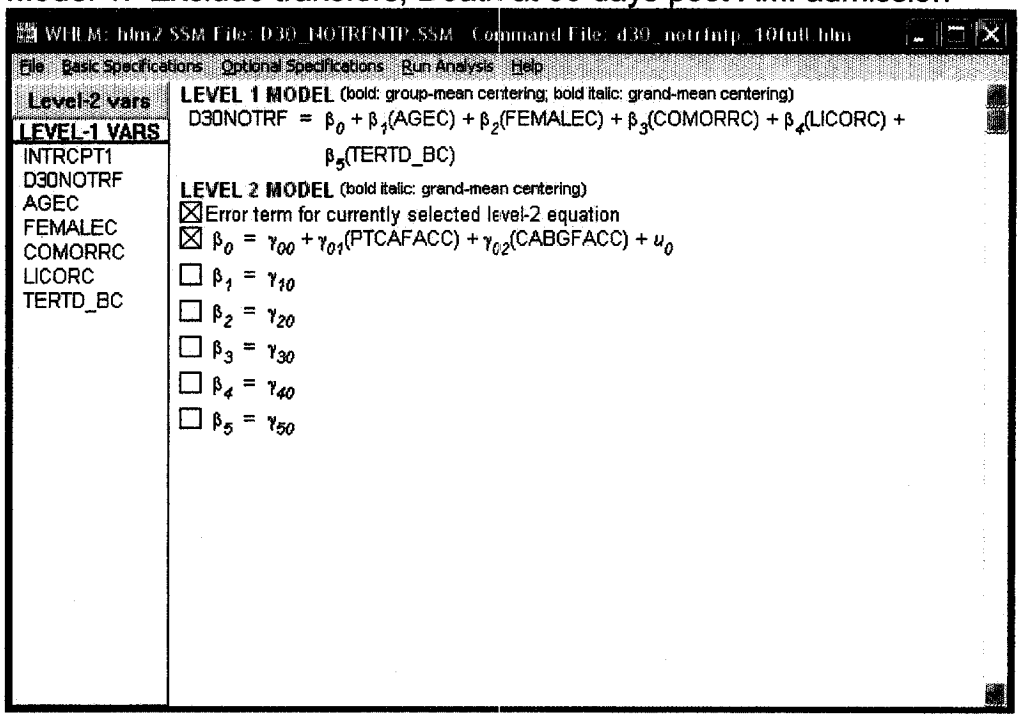


Model 3: Exclude transfers, Death at 30 days post-AMI admission

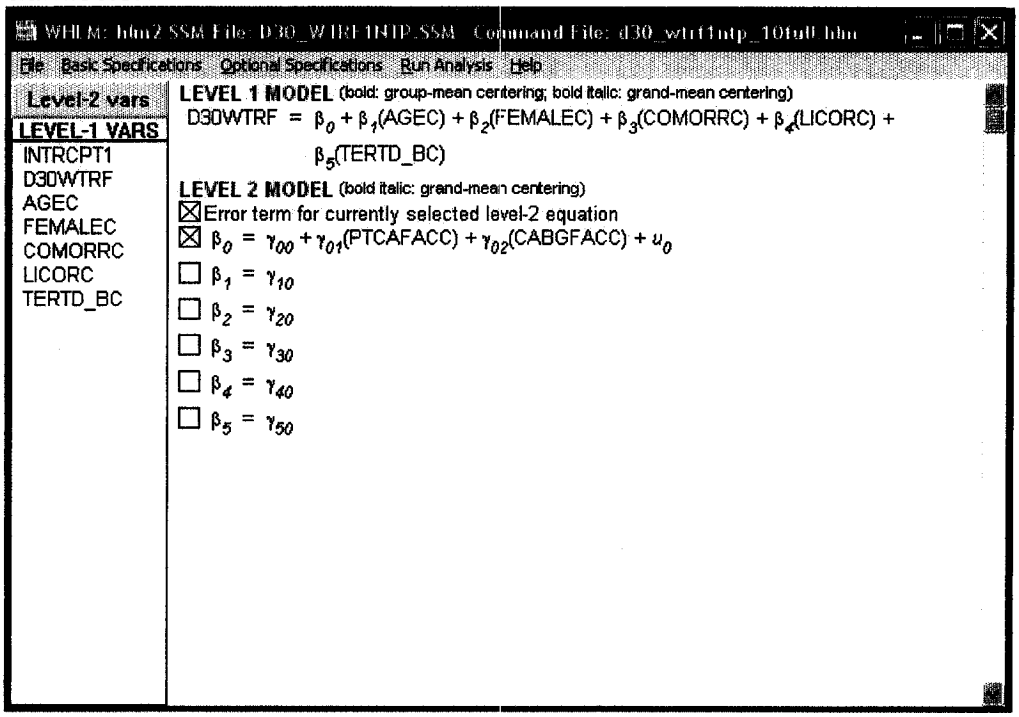


Compare Choice in Study Population

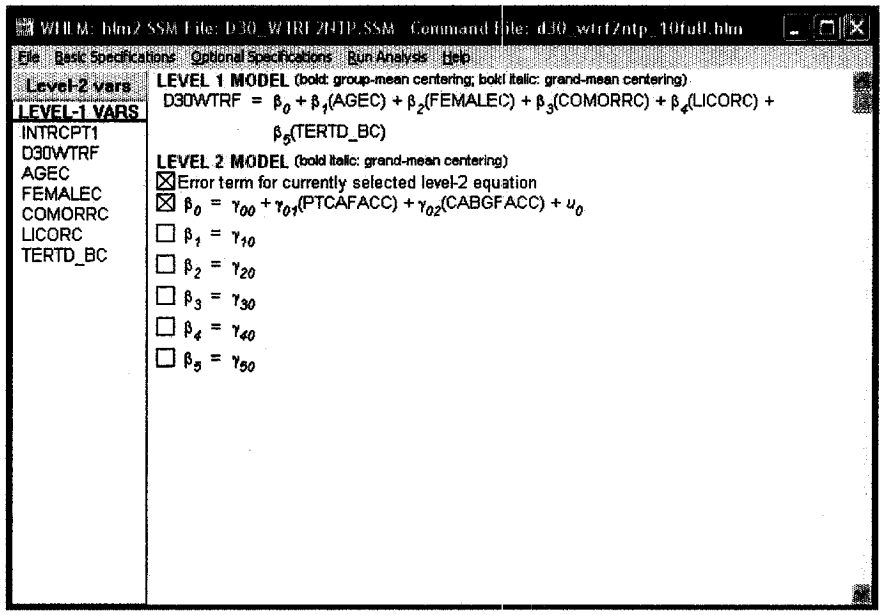
Model 1: Exclude transfers, Death at 30 days post-AMI admission



Model 2: Include transfers, assign to initial hospital, Death at 30 days post-AMI admission



Model 3: Include transfers, assign to receiving hospital, Death at 30 days post-AMI admission



Appendix 16: Empirical Bayes estimates for hospital-specific intercepts, Compared across 3 ways to define outcomes, all transfers excluded

		In-hospital death					
Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate	
BAIEHAHA	6	0.00574	0.029516	0.112486951	0.150734267	0.082996083	
BASSECOT	31	-0.08038	0.027489	0.104171911	0.138626877	0.077509954	
CHANNNAL	914	0.00658	0.007883	0.112570839	0.131161835	0.096322808	
CHASBEST	20	0.00533	0.02747	0.112446026	0.14916767	0.083873258	
CHBAICHA	411	-0.12753	0.012789	0.099853268	0.121617357	0.081622064	
CHBEAUCE	26	0.04124	0.027143	0.116080098	0.153530699	0.086827722	
CHBUCKIN	660	-0.12444	0.010682	0.100131349	0.119919507	0.083299415	
CHCHANDL	330	0.07498	0.013897	0.119587103	0.146128999	0.097316657	
CHCHARLV	60	0.12798	0.023342	0.125280724	0.161935704	0.095972634	
CHCHAUVE	351	0.04289	0.014489	0.116249504	0.142765231	0.094117832	
CHCOMTOI	30	-0.01109	0.026058	0.110817677	0.146037582	0.083263575	
CHDAMQUI	264	-0.15133	0.015853	0.097734342	0.121759258	0.078028725	
CHDOLBEA	315	0.10294	0.014327	0.122562352	0.150104342	0.09948239	
CHFLEURY	946	0.16572	0.006422	0.1294753	0.148231854	0.112777868	
CHGATINE	1034	0.16527	0.008062	0.129424589	0.150578592	0.110854561	
CHGRANBY	926	-0.03056	0.0073	0.108913647	0.126261771	0.093693522	
CHHDAMOS	332	-0.18653	0.015132	0.094673973	0.117455249	0.075931127	
CHIBOUGA	69	-0.08184	0.026753	0.104035743	0.137931012	0.077718989	
CHJONQUI	770	0.09139	0.008784	0.12132566	0.142309515	0.103064119	
CHLACHIN	542	0.21374	0.009591	0.134984672	0.159006875	0.114099279	
CHLACMEG	177	-0.04193	0.01887	0.107815069	0.136577198	0.084517123	
CHLAFLME	16	0.09054	0.028119	0.121235075	0.160822757	0.090343094	
CHLARCHI	173	-0.20858	0.019376	0.092800867	0.118461725	0.072243061	
CHLASALE	380	-0.06123	0.013397	0.105972586	0.12946527	0.086320164	
CHLASARE	222	-0.0732	0.017841	0.104843857	0.132075799	0.082691759	
CHLAUREN	727	-0.23643	0.010044	0.090482646	0.108000928	0.075565196	
CHLEGARD	1649	-0.18211	0.005866	0.095053494	0.108774557	0.082902236	
CHMANIWA	302	0.13338	0.014968	0.125873683	0.154706753	0.101767348	
CHMATANE	272	-0.16201	0.015929	0.096796592	0.120684494	0.077221745	
CHPIEBOU	1627	-0.04943	0.013651	0.107095756	0.131044551	0.08708505	
CHREDELA	1713	-0.09136	0.004985	0.103151701	0.116674978	0.09103431	
CHREOUTA	1200	-0.18228	0.014484	0.095038872	0.11735485	0.076598191	
CHRESEPI	220	-0.03538	0.018382	0.10844674	0.136936762	0.085298317	
CHRGAMIA	636	0.03072	0.009363	0.11500504	0.135761241	0.097065791	
CHRGGRPO	663	0.00433	0.008784	0.112346263	0.132010411	0.095289699	
CHRGMAUR	1077	0.08669	0.006276	0.120825505	0.138314243	0.105277907	
CHRGRIMO	868	0.151	0.007163	0.127825217	0.147487762	0.110444415	
CHROUNOR	356	-0.17262	0.014324	0.095872951	0.118222899	0.077377472	
CHSTEMAR	626	0.15132	0.009683	0.127860897	0.150954076	0.107851782	
CHSTEUST	1126	-0.09329	0.007387	0.10297329	0.119606836	0.088420625	
CHSTGEBE	963	0.12905	0.007004	0.125398027	0.144520126	0.108485207	
CHSTJOTR	1099	0.13354	0.005942	0.125891289	0.143477712	0.11018318	
CHSTJOTU	161	0.00525	0.02119	0.112438042	0.144208944	0.086955431	
CHSTLAUR	211	-0.08338	0.016996	0.103892283	0.130200933	0.082396028	
CHSTMICH	469	0.09969	0.010852	0.122213273	0.145858855	0.101943436	
CHUNILAV	861	-0.13774	0.00843	0.098939308	0.116180428	0.084013551	
CHUNSHER	1012	0.10101	0.010101	0.122354949	0.145128862	0.102725329	
CHVALDOR	542	-0.06186	0.012169	0.105912913	0.128199592	0.087113487	
CHVALLEY	1118	0.03843	0.006813	0.115792087	0.133412664	0.100229591	
CHVERDUN	1525	0.17313	0.004791	0.130312788	0.146473685	0.11569328	
CITESANT	1800	-0.06864	0.005042	0.105272592	0.119119771	0.092865392	
CLAUHAUV	180	-0.11919	0.019953	0.100605394	0.128570673	0.078177128	
CONSEILC	16	-0.01875	0.029373	0.11006513	0.147523223	0.081212056	
CSINUULI	2	-0.00878	0.030337	0.111045503	0.14947526	0.081548633	
CSTEMISC	19	-0.02362	0.028657	0.109589015	0.146396291	0.081156068	
CTRSAFAM	146	-0.03046	0.020105	0.108923353	0.138969735	0.084733944	
HARGENTE	409	0.07435	0.012259	0.119520788	0.14430757	0.098501383	
HAUTCOTE	80	0.01697	0.02347	0.113612971	0.147532633	0.086698738	

		In-hospital death					
Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate	
HAUTSBOI	2	-0.01333	0.030271	0.110597146	0.14885065	0.08123622	
HBARMEMO	333	-0.1711	0.014308	0.096004788	0.118367769	0.077495423	
HBELLLEC	154	0.07507	0.018571	0.119596579	0.150695555	0.094203623	
HBRMISPE	802	-0.01304	0.008377	0.110625675	0.129546423	0.094169413	
HCHALEMO	2465	0.17981	0.003584	0.131071713	0.14502357	0.118276399	
HCHICOUT	1214	0.02883	0.009066	0.114812817	0.135184751	0.097165946	
HCHRIROI	337	0.02332	0.014569	0.114254019	0.140465403	0.092407936	
HCLOUTIE	232	-0.08885	0.017895	0.103384136	0.130336986	0.081482738	
HCOMPONT	182	-0.09416	0.019367	0.102892956	0.130934434	0.080302052	
HDALMA	554	-0.08686	0.011708	0.103568746	0.124978458	0.085468433	
HDARTHAB	823	0.01452	0.00776	0.113366477	0.131913162	0.09713563	
HDEMONTS	245	-0.05011	0.015946	0.107030747	0.133087395	0.08557206	
HDGASPE	308	-0.08349	0.01557	0.103882043	0.12895304	0.08321965	
HDLEVIS	1232	0.04346	0.005854	0.116308076	0.132629858	0.101759248	
HDMONTMA	597	-0.05144	0.009853	0.106903699	0.126948624	0.089698643	
HDMTL	866	0.24577	0.008682	0.138768532	0.162066963	0.11834639	
HDQUEBEC	771	0.2045	0.009861	0.133909408	0.158132018	0.112899621	
HDROBERV	372	0.07173	0.014332	0.119245346	0.146171222	0.096717586	
HDSHERBR	1061	-0.06018	0.00664	0.106072107	0.122196425	0.09185282	
HDSOREL	857	-0.03731	0.008577	0.108260277	0.127070106	0.09194155	
HDSTJERO	1829	0.10158	0.004757	0.122416172	0.137695608	0.108618654	
HDUCHRRO	157	-0.01803	0.01917	0.110135674	0.13967611	0.08621672	
HENFJESU	1478	-0.10994	0.005436	0.101445468	0.115397398	0.08901064	
HGENLACH	239	0.28357	0.015047	0.143348065	0.175472202	0.116275624	
HGENLAKE	1280	0.06927	0.006216	0.118987224	0.136163583	0.103717429	
HHAUTRIC	1788	-0.08017	0.004803	0.10419151	0.117568421	0.092177634	
HJEANTAL	937	0.23796	0.006748	0.137837775	0.15810986	0.119795033	
HLAVAL	2114	-0.21048	0.00744	0.092641031	0.107864199	0.079375196	
HMAISROS	1659	0.23171	0.01324	0.137096714	0.166021793	0.112531106	
HNDEFAT	266	-0.127	0.016456	0.099900916	0.124892283	0.079456347	
HNDLAC	164	0.02383	0.019711	0.114305641	0.145254039	0.089262609	
HNDSTECX	332	0.00357	0.014479	0.112270494	0.138010691	0.090825226	
HPROVMAG	266	-0.37102	0.016647	0.080000076	0.100700947	0.063255317	
HRELIZMT	473	-0.07074	0.011278	0.105074956	0.126317544	0.087048769	
HSACCOMT	2416	0.04567	0.006068	0.116535414	0.133197616	0.101712968	
HSANTACA	1225	0.22908	0.005486	0.136785879	0.154847853	0.120530254	
HSTECROI	1145	0.05152	0.006419	0.117139052	0.134380114	0.10184976	
HSTFRAAS	1297	0.10735	0.005962	0.123037397	0.140319773	0.107617131	
HSTJOA	184	0.15251	0.016313	0.127993656	0.158626915	0.102555072	
HSTJOMAL	109	-0.10011	0.021696	0.102345032	0.13207486	0.078700518	
HSTLUC	756	0.31202	0.009993	0.14687728	0.173162945	0.123983396	
HSTSACRE	802	-0.10042	0.007436	0.102316556	0.118916503	0.087802929	
HSVPSHER	408	0.06158	0.012692	0.118183446	0.14320337	0.097039806	
INSTCARM	2294	-0.21078	0.007244	0.092615817	0.107619852	0.079517204	
INUNGESH	196	0.2545	0.015876	0.139815164	0.172235495	0.112666777	
JGH	1925	-0.25433	0.006467	0.089020315	0.102657687	0.077039041	
LEBEL	9	0.00198	0.02984	0.112112123	0.150489046	0.082570636	
MGH	1137	-0.03876	0.008508	0.108120373	0.126828311	0.091881591	
NOTRDAME	1361	-0.00153	0.007743	0.111763203	0.130064664	0.095753496	
PAVLEROY	369	-0.08095	0.016	0.104118731	0.129616545	0.083157556	
PORTCART	27	0.00004	0.029058	0.111919155	0.149671937	0.082762181	
REDMEMOR	140	0.24806	0.019551	0.13904244	0.175200511	0.109357305	
RESARIYA	1360	0.08684	0.005249	0.120841439	0.136757775	0.106548862	
RVH	917	-0.22192	0.009926	0.091683871	0.109294035	0.076666938	
STJEANEU	54	0.03972	0.024981	0.115924228	0.151636811	0.087752465	
STMARYS	901	-0.20096	0.00698	0.093444379	0.108270021	0.080465656	
THORACIQ	8	0.00771	0.029414	0.112683774	0.150911993	0.083190542	
TULATTAV	4	-0.01739	0.030136	0.110198414	0.148240858	0.080990352	

Choice of outcome	Overall Intercept	SE	Overall death rate	UCL dth rate	LCL dth rate
In-hospital death	-2.071326	0.02506	0.111915179	0.116890831	0.107125633
Dth 7d post AMI	-2.469084	0.024655	0.078054127	0.081603265	0.074646803
Dth 30d post AMI	-2.096735	0.025384	0.109414567	0.114357652	0.104659896

		Death at 7 days post AMI admission					
Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate	
BAIEHAHA	6	-0.00609	0.023694	0.077617005	0.102157949	0.058586732	
BASSECOT	31	-0.03076	0.022678	0.075869117	0.09933071	0.057594713	
CHANNNAL	914	-0.04405	0.008909	0.074942552	0.088819523	0.063083584	
CHASBEST	20	-0.02391	0.022601	0.076350788	0.099900118	0.057995036	
CHBAICHA	411	-0.05385	0.012782	0.074265979	0.091011937	0.060396506	
CHBEAUCE	26	0.02116	0.022426	0.079590496	0.103920043	0.060571904	
CHBUCKIN	660	-0.12214	0.011303	0.069705369	0.084490202	0.057345659	
CHCHANDL	330	0.08861	0.013791	0.084673822	0.104303078	0.068456347	
CHCHARLV	60	0.05281	0.020384	0.081940111	0.105605187	0.063203394	
CHCHAUVE	351	-0.03045	0.014658	0.075890855	0.094299196	0.060834672	
CHCOMTOI	30	-0.03891	0.02189	0.075299668	0.098145094	0.057433361	
CHDAMQUI	264	-0.0973	0.015328	0.071333475	0.089177144	0.056837389	
CHDOLBEA	315	0.11808	0.014052	0.086986002	0.107296029	0.070218055	
CHFLEURY	946	0.12212	0.007056	0.087307393	0.101349068	0.07504869	
CHGATINE	1034	0.07134	0.008943	0.08334489	0.098643205	0.070234277	
CHGRANBY	926	0.05453	0.00795	0.082069593	0.096233373	0.06982939	
CHHDAMOS	332	-0.1533	0.01511	0.067711644	0.084597788	0.053997239	
CHIBOUGA	69	-0.05453	0.022211	0.074219242	0.096956506	0.056480597	
CHJONQUI	770	0.06634	0.009614	0.082963692	0.098805839	0.06946582	
CHLACHIN	542	0.15479	0.010197	0.089946037	0.107515625	0.075006274	
CHLACMEG	177	0.05761	0.017134	0.082301921	0.103872728	0.064886281	
CHLAFLME	16	0.05435	0.023013	0.082056034	0.107416977	0.062265071	
CHLARCHI	173	-0.07177	0.017549	0.07304333	0.092691342	0.057297143	
CHLASALE	380	-0.00819	0.013307	0.077466793	0.095248048	0.062774693	
CHLASARE	222	-0.02697	0.016765	0.076135273	0.096018004	0.060096011	
CHLAUREN	727	-0.14763	0.010379	0.068070451	0.081882932	0.056444696	
CHLEGARD	1649	-0.13699	0.006662	0.06874853	0.07972446	0.059186508	
CHMANIWA	302	0.09885	0.01477	0.085470847	0.106022289	0.068597431	
CHMATANE	272	-0.12923	0.015384	0.069247007	0.086652482	0.055126672	
CHPIEBOU	1627	-0.03455	0.012076	0.075603815	0.092100951	0.06186031	
CHREDELA	1713	-0.01168	0.005559	0.077217746	0.088295326	0.067427179	
CHREOUTA	1200	-0.21234	0.012979	0.064078423	0.078846033	0.051920837	
CHRESEPI	220	-0.03341	0.017324	0.075683526	0.095823425	0.059498032	
CHRGAMIA	636	0.0088	0.010153	0.078689745	0.094251896	0.06551125	
CHRGGRPO	663	0.05153	0.009333	0.081843873	0.09724625	0.068695371	
CHRGMAUR	1077	0.12391	0.006921	0.087450134	0.101367958	0.07528314	
CHRGRIMO	868	0.11227	0.007989	0.086525681	0.101412581	0.073645008	
CHROUNOR	356	-0.08591	0.014134	0.0720917	0.089319161	0.057975458	
CHSTEMAR	626	0.06359	0.01054	0.08275471	0.099367555	0.068707412	
CHSTEUST	1126	-0.00311	0.007981	0.077830619	0.091363873	0.066156024	
CHSTGEBE	963	0.03878	0.008035	0.080890863	0.094952282	0.068753601	
CHSTJOTR	1099	0.06552	0.00687	0.082901327	0.096119192	0.071357625	
CHSTJOTU	161	0.02662	0.019032	0.079991392	0.102286871	0.06221884	
CHSTLAUR	211	-0.14668	0.016231	0.068130741	0.08579782	0.053887148	
CHSTMICH	469	0.06037	0.011298	0.082510619	0.099716228	0.068049367	
CHUNILAV	861	-0.24277	0.009619	0.062277492	0.07449386	0.051952048	
CHUNSHER	1012	0.03224	0.010892	0.080405961	0.096888158	0.066521117	
CHVALDOR	542	0.03591	0.012203	0.080677742	0.09826451	0.066008138	
CHVALLEY	1118	0.10153	0.007388	0.085680564	0.09983267	0.073371115	
CHVERDUN	1525	0.17581	0.005404	0.091681539	0.104406876	0.080368013	
CITESANT	1800	-0.07476	0.0058	0.072841141	0.083587328	0.063380958	
CLAUHAUV	180	-0.1233	0.018392	0.069630184	0.088945859	0.054259325	
CONSEILC	16	-0.02811	0.023647	0.076055125	0.100128879	0.057400169	
CSINUULI	2	-0.00463	0.024129	0.077721594	0.102545377	0.058515245	
CSTEMISC	19	-0.00095	0.023259	0.07798579	0.102374404	0.059025212	
CTRSAFAM	146	-0.0123	0.018251	0.077173579	0.098270091	0.060303167	
HARGENTE	409	0.09139	0.012386	0.084889532	0.103441169	0.069407463	
HAUTCOTE	80	0.09722	0.020245	0.085343523	0.109780461	0.065943263	

		Death at 7 days post AMI admission					
Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate	
HAUTSBOI	2	-0.00797	0.024079	0.077482517	0.10220944	0.05834885	
HBARMEMO	333	-0.15624	0.014275	0.067526287	0.083850273	0.054192274	
HBELLLEC	154	0.04482	0.017082	0.08134106	0.102652317	0.064137921	
HBRMISPE	802	0.09377	0.008755	0.085074601	0.100478389	0.071843675	
HCHALEMO	2465	0.19261	0.004068	0.093090207	0.104194545	0.083059565	
HCHICOUT	1214	-0.12534	0.010169	0.069498146	0.08341897	0.057754028	
HCHRIROI	337	-0.06159	0.014677	0.0737356	0.091685819	0.059071121	
HCLOUTIE	232	-0.1017	0.016905	0.071042546	0.089810877	0.05595523	
HCOMPONT	182	-0.05442	0.017666	0.074226801	0.094234548	0.058194141	
HDALMA	554	-0.05496	0.012132	0.074189702	0.090449479	0.060657954	
HDARTHAB	823	0.07339	0.008378	0.08350164	0.098296935	0.070758527	
HDEMONTS	245	-0.03979	0.01544	0.075238416	0.094035418	0.059950164	
HDGASPE	308	0.00143	0.0149	0.078157094	0.097228508	0.062567282	
HDLEVIS	1232	0.0299	0.006619	0.080233109	0.092816206	0.069225729	
HDMONTMA	597	-0.05568	0.010612	0.074140263	0.089247688	0.061417696	
HDMTL	866	0.19052	0.009237	0.09291391	0.110053989	0.078208678	
HDQUEBEC	771	0.25952	0.010131	0.09889492	0.117919163	0.082652322	
HDROBERV	372	0.07882	0.014179	0.083918134	0.10369045	0.067631631	
HDSHERBR	1061	-0.08554	0.007473	0.072116454	0.084309117	0.061568518	
HDSOREL	857	0.00577	0.0093	0.078470358	0.093274039	0.065845574	
HDSTJERO	1829	0.17161	0.005229	0.091332379	0.103795796	0.080231546	
HDUCHRRO	157	-0.02856	0.017789	0.07602351	0.096544031	0.059577021	
HENFJESU	1478	-0.1371	0.006419	0.068741487	0.079500626	0.059344553	
HGENLACH	239	0.16067	0.01492	0.09042851	0.112146072	0.072572874	
HGENLAKE	1280	-0.10523	0.007433	0.070809935	0.082766939	0.060466436	
HHAUTRIC	1788	0.03116	0.005321	0.080326141	0.091541945	0.070378051	
HJEANTAL	937	0.11328	0.007555	0.086605544	0.101065462	0.074044067	
HLAVAL	2114	-0.17136	0.007859	0.066580437	0.078226718	0.056561643	
HMAISROS	1659	0.2469	0.011606	0.097775972	0.118049599	0.08066565	
HNDEFAT	266	-0.07218	0.015655	0.073015574	0.091452379	0.058058115	
HNDLAC	164	0.02634	0.018006	0.079970788	0.101584784	0.062634947	
HNDSTECX	332	-0.08904	0.014878	0.0718826	0.08955731	0.057475898	
HPROVMAG	266	-0.21178	0.015744	0.064112015	0.080547389	0.050844765	
HRELIZMT	473	-0.08512	0.01156	0.072144564	0.087586228	0.059248521	
HSACCOMT	2416	0.14897	0.006141	0.089470772	0.102797596	0.07772199	
HSANTACA	1225	0.08748	0.00634	0.084586283	0.097480254	0.073259391	
HSTECROI	1145	0.06542	0.007131	0.082893725	0.09637642	0.071148695	
HSTFRAAS	1297	0.07853	0.006669	0.083895843	0.097045461	0.072385158	
HSTJOA	184	0.08082	0.015884	0.084072014	0.105152486	0.066901698	
HSTJOMAL	109	-0.05252	0.019224	0.074357469	0.095362513	0.057684086	
HSTLUC	756	0.13549	0.010809	0.088378674	0.106232084	0.073279709	
HSTSACRE	802	-0.09948	0.008165	0.071189196	0.083826418	0.060331638	
HSVPSHER	408	-0.00213	0.012964	0.077900986	0.095517865	0.06330587	
INSTCARM	2294	-0.1301	0.007493	0.069190955	0.080949003	0.059031095	
INUNGESH	196	0.20305	0.015171	0.09397535	0.116642159	0.075337666	
JGH	1925	-0.29659	0.006994	0.059207521	0.069025304	0.050710103	
LEBEL	9	0.00707	0.023866	0.078564416	0.103472698	0.059255831	
MGH	1137	-0.03745	0.009007	0.07540139	0.08943772	0.063414503	
NOTRDAME	1361	0.09787	0.007999	0.085394276	0.100117723	0.072661245	
PAVLEROY	369	-0.12941	0.015798	0.069235407	0.086895712	0.054948316	
PORTCART	27	0.0117	0.023461	0.078900246	0.103663009	0.059659038	
REDMEMOR	140	0.05466	0.018172	0.082079387	0.104311693	0.06424565	
RESARIYA	1360	0.08727	0.005991	0.084570024	0.097079265	0.073541387	
RVH	917	-0.10377	0.01013	0.070906057	0.085053579	0.058960139	
STJEANEU	54	0.06012	0.02118	0.082491696	0.106812808	0.063315896	
STMARYS	901	-0.18457	0.007614	0.065764154	0.077085041	0.056004987	
THORACIQ	8	-0.00438	0.023686	0.077739516	0.102310221	0.058683931	
TULATTAV	4	-0.0105	0.024013	0.077301869	0.101939322	0.058232867	

		Death at 30 days post AMI admission				
Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate
BAIEHAHA	6	0.00787	0.030503	0.110183804	0.148483014	0.080825675
BASSECOT	31	-0.07868	0.028392	0.101980057	0.136442588	0.075461399
CHANNNAL	914	0.00315	0.008089	0.109721891	0.128162416	0.093649655
CHASBEST	20	0.04008	0.028318	0.113381656	0.150993876	0.084209269
CHBAICHA	411	-0.06376	0.012868	0.10335457	0.125850351	0.084491251
CHBEAUCE	26	0.01856	0.028047	0.111236263	0.148056138	0.082684381
CHBUCKIN	660	-0.15088	0.011093	0.095555389	0.114946498	0.07914298
CHCHANDL	330	0.07202	0.01427	0.116632329	0.143001742	0.094588732
CHCHARLV	60	0.0953	0.024125	0.119052339	0.154857044	0.090638256
CHCHAUVE	351	-0.08134	0.015468	0.101736712	0.126274407	0.081522301
CHCOMTOI	30	-0.08358	0.027017	0.101532189	0.134918508	0.075684699
CHDAMQUI	264	-0.19439	0.016507	0.091860657	0.115137516	0.072901881
CHDOLBEA	315	0.05576	0.014894	0.114967489	0.141635171	0.092778196
CHFLEURY	946	0.25497	0.006417	0.136842683	0.156466605	0.119331798
CHGATINE	1034	0.08741	0.008558	0.118227328	0.138475932	0.100593855
CHGRANBY	926	0.08971	0.007143	0.118467313	0.136888978	0.102231087
CHHDAMOS	332	-0.19546	0.015616	0.091771434	0.114328972	0.073296254
CHIBOUGA	69	-0.10765	0.027675	0.099357405	0.13258159	0.073751121
CHJONQUI	770	0.01086	0.009298	0.110477296	0.130462031	0.093225693
CHLACHIN	542	0.22177	0.009798	0.132968275	0.156969092	0.112149029
CHLACMEG	177	-0.00854	0.019257	0.108585175	0.137847211	0.084922988
CHLAFLME	16	0.06871	0.029075	0.116291735	0.155274435	0.086098383
CHLARCHI	173	-0.1758	0.019819	0.093423288	0.119559704	0.07252976
CHLASALE	380	-0.00646	0.013546	0.108786672	0.132955488	0.088562535
CHLASARE	222	-0.00236	0.018028	0.109184814	0.137533479	0.086096121
CHLAUREN	727	-0.219	0.010244	0.089828152	0.107421107	0.074874793
CHLEGARD	1649	-0.11451	0.005829	0.09874522	0.112885189	0.086204308
CHMANIWA	302	0.20307	0.015065	0.130827153	0.160691028	0.105813662
CHMATANE	272	-0.14349	0.0163	0.096195978	0.120258031	0.076529607
CHPIEBOU	1627	-0.06473	0.014107	0.103264712	0.12689785	0.083611459
CHREDELA	1713	0.01063	0.004887	0.110454695	0.124652932	0.097693179
CHREOUTA	1200	-0.23023	0.015025	0.088914217	0.11039477	0.071278448
CHRESEPI	220	-0.09512	0.019189	0.100484301	0.127822849	0.078466832
CHRGAMIA	636	0.01612	0.009649	0.110995267	0.131462911	0.093371681
CHRGGRPO	663	-0.04268	0.009167	0.105324502	0.124362024	0.088905378
CHRGMAUR	1077	0.15583	0.006256	0.125548466	0.143578709	0.109492939
CHRGRIMO	868	0.14431	0.007341	0.124289177	0.143749236	0.107133908
CHROUNOR	356	-0.10632	0.014435	0.099476484	0.122650203	0.080280597
CHSTEMAR	626	0.17393	0.009835	0.127549099	0.150788673	0.107438074
CHSTEUST	1126	-0.10993	0.007633	0.099153565	0.115533348	0.084873189
CHSTGEBE	963	-0.05412	0.00772	0.104251354	0.121463625	0.089230453
CHSTJOTR	1099	0.15849	0.006022	0.125840788	0.143545889	0.110038879
CHSTJOTU	161	0.01658	0.021773	0.111040666	0.142957058	0.085538698
CHSTLAUR	211	-0.12562	0.017731	0.097760888	0.123319322	0.077034087
CHSTMICH	469	0.03598	0.011406	0.112970151	0.13570518	0.093631355
CHUNILAV	861	-0.21994	0.008968	0.089751328	0.106114031	0.075698073
CHUNSHER	1012	-0.0244	0.010704	0.107059519	0.128045326	0.089161451
CHVALDOR	542	0.00924	0.012158	0.110318195	0.133382254	0.090824332
CHVALLEY	1118	0.03394	0.006988	0.112765888	0.130227331	0.097383608
CHVERDUN	1525	0.17244	0.004919	0.127383383	0.143461906	0.112869407
CITESANT	1800	-0.08191	0.005214	0.101684633	0.115360597	0.089465986
CLAUHAUV	180	-0.18904	0.020892	0.092307942	0.118943274	0.071155437
CONSEILC	16	-0.01792	0.03036	0.107680571	0.145151998	0.07898868
CSINUULI	2	-0.00862	0.031375	0.108577432	0.147018378	0.079253761
CSTEMISC	19	-0.02188	0.029609	0.107300664	0.144136197	0.079009806
CTRSAFAM	146	-0.03712	0.020705	0.105849579	0.13565864	0.081969458
HARGENTE	409	0.19932	0.012091	0.130401325	0.156844677	0.107845969
HAUTCOTE	80	0.07704	0.024019	0.117150532	0.152395769	0.0891988

		Death at 30 days post AMI admission					
Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate	
HAUTSBOI	2	-0.0135	0.031298	0.108106006	0.146354195	0.07892937	
HBARMEMO	333	-0.10674	0.014419	0.099438867	0.122590973	0.080259228	
HBELLLEC	154	0.14203	0.018921	0.124041231	0.156421339	0.097588576	
HBRMISPE	802	0.09025	0.008238	0.118523718	0.138406487	0.101161846	
HCHALEMO	2465	0.26044	0.003553	0.137490066	0.151940064	0.124213029	
HCHICOUT	1214	-0.09187	0.009598	0.100778441	0.119561941	0.08466212	
HCHRIROI	337	-0.07881	0.015521	0.101968152	0.126599935	0.081680635	
HCLOUTIE	232	-0.1268	0.018607	0.097656857	0.123881451	0.076499039	
HCOMPONT	182	-0.1015	0.01997	0.099909099	0.127721448	0.07761422	
HDALMA	554	-0.11964	0.012166	0.098289616	0.119183206	0.08072313	
HDARTHAB	823	0.08044	0.007754	0.11750264	0.136613854	0.100752949	
HDEMONTS	245	-0.05964	0.016449	0.103737004	0.129543863	0.082583462	
HDGASPE	308	-0.04845	0.015837	0.104782025	0.130275108	0.083796944	
HDLEVIS	1232	0.06322	0.005941	0.115728726	0.132108592	0.101143086	
HDMONTMA	597	-0.0693	0.010167	0.102842291	0.12256029	0.085985731	
HDMTL	866	0.20997	0.008936	0.131613762	0.154271365	0.111843776	
HDQUEBEC	771	0.22064	0.009999	0.132838054	0.157081592	0.111839745	
HDROBERV	372	0.0498	0.014824	0.114362449	0.14084402	0.092324906	
HDSHERBR	1061	-0.08473	0.00689	0.10142733	0.117245905	0.087531343	
HDSOREL	857	-0.04722	0.008836	0.104897458	0.123497894	0.088814627	
HDSTJERO	1829	0.20124	0.004658	0.130619202	0.146574315	0.116164456	
HDUCHRRO	157	-0.05909	0.019891	0.103788152	0.132458322	0.080745967	
HENFJESU	1478	-0.06698	0.005487	0.103056545	0.11727114	0.090388495	
HGENLACH	239	0.28291	0.015441	0.140176475	0.172177643	0.113308979	
HGENLAKE	1280	-0.08244	0.006809	0.101636231	0.117383718	0.087791198	
HHAUTRIC	1788	-0.01927	0.004791	0.107550925	0.121282643	0.095205475	
HJEANTAL	937	0.29788	0.006802	0.141990502	0.16284567	0.123412459	
HLAVAL	2114	-0.18016	0.007493	0.09305467	0.108395773	0.079690712	
HMAISROS	1659	0.29495	0.013645	0.141633917	0.17181278	0.116013405	
HNDEFAT	266	-0.17692	0.017171	0.093328472	0.117448189	0.073748182	
HNDLAC	164	0.01781	0.020306	0.111162138	0.14189651	0.086414358	
HNDSTECX	332	-0.1212	0.015458	0.098151442	0.121933363	0.078592783	
HPROVMAG	266	-0.26993	0.016698	0.085750233	0.107801954	0.067866238	
HRELIZMT	473	0.022	0.011272	0.111576806	0.133930699	0.092555196	
HSACCOMT	2416	0.11356	0.006085	0.120980788	0.13820463	0.105640352	
HSANTACA	1225	0.18769	0.005708	0.129088179	0.146669592	0.113334361	
HSTECROI	1145	0.0737	0.006506	0.11680553	0.13412808	0.101458033	
HSTFRAAS	1297	0.12902	0.006079	0.12263453	0.14004722	0.107117162	
HSTJOA	184	0.10447	0.016963	0.120017442	0.149695598	0.095561916	
HSTJOMAL	109	-0.02179	0.022085	0.107309285	0.138566328	0.082428364	
HSTLUC	756	0.28981	0.010242	0.141010178	0.166787582	0.118649416	
HSTSACRE	802	-0.1304	0.007741	0.097340084	0.1135795	0.083204608	
HSVPSHER	408	0.0668	0.013024	0.116095592	0.141091422	0.095038049	
INSTCARM	2294	-0.15797	0.007246	0.094944393	0.110282076	0.081544322	
INUNGESH	196	0.25527	0.016292	0.136878122	0.169202429	0.109912064	
JGH	1925	-0.25354	0.006609	0.087043916	0.100567459	0.075186898	
LEBEL	9	0.00264	0.030844	0.109672082	0.148063497	0.08029695	
MGH	1137	-0.02332	0.008632	0.107162808	0.125872778	0.090944578	
NOTRDAME	1361	0.03904	0.007824	0.113277151	0.131892726	0.096995441	
PAVLEROY	369	-0.18001	0.016947	0.09306733	0.116954585	0.073651974	
PORTCART	27	0.00137	0.03002	0.109548136	0.147320922	0.080545368	
REDMEMOR	140	0.09073	0.020818	0.118573876	0.151458479	0.092054588	
RESARIYA	1360	0.01758	0.005522	0.111139415	0.126362907	0.097545185	
RVH	917	-0.14175	0.009875	0.096347364	0.114689104	0.080671649	
STJEANEU	54	0.02346	0.025789	0.111721614	0.146975858	0.084089997	
STMARYS	901	-0.13597	0.007033	0.096851772	0.112212945	0.083395904	
THORACIQ	8	-0.01987	0.030433	0.107493348	0.144961056	0.078817138	
TULATTAV	4	-0.0175	0.031158	0.107720934	0.145758466	0.078695333	

Appendix 17: Empirical Bayes estimates for hospital-specific intercepts, Compared across 3 ways to deal with transfers, using death at 30 days as outcome

	Exclude Transfers						
Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate	
BAIEHAHA	6	0.00787	0.030503	0.110183804	0.148483014	0.080825675	
BASSECOT	31	-0.07868	0.028392	0.101980057	0.136442588	0.075461399	
CHANNNAL	914	0.00315	0.008089	0.109721891	0.128162416	0.093649655	
CHASBEST	20	0.04008	0.028318	0.113381656	0.150993876	0.084209269	
CHBAICHA	411	-0.06376	0.012868	0.10335457	0.125850351	0.084491251	
CHBEAUCE	26	0.01856	0.028047	0.111236263	0.148056138	0.082684381	
CHBUCKIN	660	-0.15088	0.011093	0.095555389	0.114946498	0.07914298	
CHCHANDL	330	0.07202	0.01427	0.116632329	0.143001742	0.094588732	
CHCHARLV	60	0.0953	0.024125	0.119052339	0.154857044	0.090638256	
CHCHAUVE	351	-0.08134	0.015468	0.101736712	0.126274407	0.081522301	
CHCOMTOI	30	-0.08358	0.027017	0.101532189	0.134918508	0.075684699	
CHDAMQUI	264	-0.19439	0.016507	0.091860657	0.115137516	0.072901881	
CHDOLBEA	315	0.05576	0.014894	0.114967489	0.141635171	0.092778196	
CHFLEURY	946	0.25497	0.006417	0.136842683	0.156466605	0.119331798	
CHGATINE	1034	0.08741	0.008558	0.118227328	0.138475932	0.100593855	
CHGRANBY	926	0.08971	0.007143	0.118467313	0.136888978	0.102231087	
CHHDAMOS	332	-0.19546	0.015616	0.091771434	0.114328972	0.073296254	
CHIBOUGA	69	-0.10765	0.027675	0.099357405	0.13258159	0.073751121	
CHJONQUI	770	0.01086	0.009298	0.110477296	0.130462031	0.093225693	
CHLACHIN	542	0.22177	0.009798	0.132968275	0.156969092	0.112149029	
CHLACMEG	177	-0.00854	0.019257	0.108585175	0.137847211	0.084922988	
CHLAFLME	16	0.06871	0.029075	0.116291735	0.155274435	0.086098383	
CHLARCHI	173	-0.1758	0.019819	0.093423288	0.119559704	0.07252976	
CHLASALE	380	-0.00646	0.013546	0.108786672	0.132955488	0.088562535	
CHLASARE	222	-0.00236	0.018028	0.109184814	0.137533479	0.086096121	
CHLAUREN	727	-0.219	0.010244	0.089828152	0.107421107	0.074874793	
CHLEGARD	1649	-0.11451	0.005829	0.09874522	0.112885189	0.086204308	
CHMANIWA	302	0.20307	0.015065	0.130827153	0.160691028	0.105813662	
CHMATANE	272	-0.14349	0.0163	0.096195978	0.120258031	0.076529607	
CHPIEBOU	1627	-0.06473	0.014107	0.103264712	0.12689785	0.083611459	
CHREDELA	1713	0.01063	0.004887	0.110454695	0.124652932	0.097693179	
CHREOUTA	1200	-0.23023	0.015025	0.088914217	0.11039477	0.071278448	
CHRESEPI	220	-0.09512	0.019189	0.100484301	0.127822849	0.078466832	
CHRGAMIA	636	0.01612	0.009649	0.110995267	0.131462911	0.093371681	
CHRGGRPO	663	-0.04268	0.009167	0.105324502	0.124362024	0.088905378	
CHRGMAUR	1077	0.15583	0.006256	0.125548466	0.143578709	0.109492939	
CHRGRIMO	868	0.14431	0.007341	0.124289177	0.143749236	0.107133908	
CHROUNOR	356	-0.10632	0.014435	0.099476484	0.122650203	0.080280597	
CHSTEMAR	626	0.17393	0.009835	0.127549099	0.150788673	0.107438074	
CHSTEUST	1126	-0.10993	0.007633	0.099153565	0.115533348	0.084873189	
CHSTGEBE	963	-0.05412	0.00772	0.104251354	0.121463625	0.089230453	
CHSTJOTR	1099	0.15849	0.006022	0.125840788	0.143545889	0.110038879	
CHSTJOTU	161	0.01658	0.021773	0.111040666	0.142957058	0.085538698	
CHSTLAUR	211	-0.12562	0.017731	0.097760888	0.123319322	0.077034087	
CHSTMICH	469	0.03598	0.011406	0.112970151	0.13570518	0.093631355	
CHUNILAV	861	-0.21994	0.008968	0.089751328	0.106114031	0.075698073	
CHUNSHER	1012	-0.0244	0.010704	0.107059519	0.128045326	0.089161451	
CHVALDOR	542	0.00924	0.012158	0.110318195	0.133382254	0.090824332	
CHVALLEY	1118	0.03394	0.006988	0.112765888	0.130227331	0.097383608	
CHVERDUN	1525	0.17244	0.004919	0.127383383	0.143461906	0.112869407	
CITESANT	1800	-0.08191	0.005214	0.101684633	0.115360597	0.089465986	
CLAUHAUV	180	-0.18904	0.020892	0.092307942	0.118943274	0.071155437	
CONSEILC	16	-0.01792	0.03036	0.107680571	0.145151998	0.07898868	
CSINUULI	2	-0.00862	0.031375	0.108577432	0.147018378	0.079253761	
CSTEMISC	19	-0.02188	0.029609	0.107300664	0.144136197	0.079009806	
CTRSAFAM	146	-0.03712	0.020705	0.105849579	0.13565864	0.081969458	
HARGENTE	409	0.19932	0.012091	0.130401325	0.156844677	0.107845969	
HAUTCOTE	80	0.07704	0.024019	0.117150532	0.152395769	0.0891988	

Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate
HAUTSBOI	2	-0.0135	0.031298	0.108106006	0.146354195	0.07892937
HBARMEMO	333	-0.10674	0.014419	0.099438867	0.122590973	0.080259228
HBELLLEC	154	0.14203	0.018921	0.124041231	0.156421339	0.097588576
HBRMISPE	802	0.09025	0.008238	0.118523718	0.138406487	0.101161846
HCHALEMO	2465	0.26044	0.003553	0.137490066	0.151940064	0.124213029
HCHICOUT	1214	-0.09187	0.009598	0.100778441	0.119561941	0.08466212
HCHRIROI	337	-0.07881	0.015521	0.101968152	0.126599935	0.081680635
HCLOUTIE	232	-0.1268	0.018607	0.097656857	0.123881451	0.076499039
HCOMPONT	182	-0.1015	0.01997	0.099909099	0.127721448	0.07761422
HDALMA	554	-0.11964	0.012166	0.098289616	0.119183206	0.08072313
HDARTHAB	823	0.08044	0.007754	0.11750264	0.136613854	0.100752949
HDEMONTS	245	-0.05964	0.016449	0.103737004	0.129543863	0.082583462
HDGASPE	308	-0.04845	0.015837	0.104782025	0.130275108	0.083796944
HDLEVIS	1232	0.06322	0.005941	0.115728726	0.132108592	0.101143086
HDMONTMA	597	-0.0693	0.010167	0.102842291	0.12256029	0.085985731
HDMTL	866	0.20997	0.008936	0.131613762	0.154271365	0.111843776
HDQUEBEC	771	0.22064	0.009999	0.132838054	0.157081592	0.111839745
HDROBERV	372	0.0498	0.014824	0.114362449	0.14084402	0.092324906
HDSHERBR	1061	-0.08473	0.00689	0.10142733	0.117245905	0.087531343
HDSOREL	857	-0.04722	0.008836	0.104897458	0.123497894	0.088814627
HDSTJERO	1829	0.20124	0.004658	0.130619202	0.146574315	0.116164456
HDUCHRRO	157	-0.05909	0.019891	0.103788152	0.132458322	0.080745967
HENFJESU	1478	-0.06698	0.005487	0.103056545	0.11727114	0.090388495
HGENLACH	239	0.28291	0.015441	0.140176475	0.172177643	0.113308979
HGENLAKE	1280	-0.08244	0.006809	0.101636231	0.117383718	0.087791198
HHAUTRIC	1788	-0.01927	0.004791	0.107550925	0.121282643	0.095205475
HJEANTAL	937	0.29788	0.006802	0.141990502	0.16284567	0.123412459
HLAVAL	2114	-0.18016	0.007493	0.09305467	0.108395773	0.079690712
HMAISROS	1659	0.29495	0.013645	0.141633917	0.17181278	0.116013405
HNDEFAT	266	-0.17692	0.017171	0.093328472	0.117448189	0.073748182
HNDLAC	164	0.01781	0.020306	0.111162138	0.14189651	0.086414358
HNDSTECX	332	-0.1212	0.015458	0.098151442	0.121933363	0.078592783
HPROVMAG	266	-0.26993	0.016698	0.085750233	0.107801954	0.067866238
HRELIZMT	473	0.022	0.011272	0.111576806	0.133930699	0.092555196
HSACCOMT	2416	0.11356	0.006085	0.120980788	0.13820463	0.105640352
HSANTACA	1225	0.18769	0.005708	0.129088179	0.146669592	0.113334361
HSTECROI	1145	0.0737	0.006506	0.11680553	0.13412808	0.101458033
HSTFRAAS	1297	0.12902	0.006079	0.12263453	0.14004722	0.107117162
HSTJOA	184	0.10447	0.016963	0.120017442	0.149695598	0.095561916
HSTJOMAL	109	-0.02179	0.022085	0.107309285	0.138566328	0.082428364
HSTLUC	756	0.28981	0.010242	0.141010178	0.166787582	0.118649416
HSTSACRE	802	-0.1304	0.007741	0.097340084	0.1135795	0.083204608
HSVPSHER	408	0.0668	0.013024	0.116095592	0.141091422	0.095038049
INSTCARM	2294	-0.15797	0.007246	0.094944393	0.110282076	0.081544322
INUNGESH	196	0.25527	0.016292	0.136878122	0.169202429	0.109912064
JGH	1925	-0.25354	0.006609	0.087043916	0.100567459	0.075186898
LEBEL	9	0.00264	0.030844	0.109672082	0.148063497	0.08029695
MGH	1137	-0.02332	0.008632	0.107162808	0.125872778	0.090944578
NOTRDAME	1361	0.03904	0.007824	0.113277151	0.131892726	0.096995441
PAVLEROY	369	-0.18001	0.016947	0.09306733	0.116954585	0.073651974
PORTCART	27	0.00137	0.03002	0.109548136	0.147320922	0.080545368
REDMEMOR	140	0.09073	0.020818	0.118573876	0.151458479	0.092054588
RESARIYA	1360	0.01758	0.005522	0.111139415	0.126362907	0.097545185
RVH	917	-0.14175	0.009875	0.096347364	0.114689104	0.080671649
STJEANEU	54	0.02346	0.025789	0.111721614	0.146975858	0.084089997
STMARYS	901	-0.13597	0.007033	0.096851772	0.112212945	0.083395904
THORACIQ	8	-0.01987	0.030433	0.107493348	0.144961056	0.078817138
TULATTAV	4	-0.0175	0.031158	0.107720934	0.145758466	0.078695333

	Choice Study Popn	Overall intercept	SE	overall death rate	UCL dth rate	LCL dth rate
	No transfers	-2.096735	0.025384	0.109414567	0.114357652	0.104659896
	Assign transfers to Hos 1	-2.179419	0.025462	0.101613954	0.106261188	0.097147871
	Assign transfers to Hos 2	-2.176756	0.024254	0.101857314	0.106289237	0.097590008

	Include transfers and assign them to referring (1st) hospital						
Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate	
BAIEHAHA	6	0.00983	0.031946	0.102514842	0.139521551	0.074474252	
BASSECOT	48	-0.05473	0.028721	0.096725537	0.129884261	0.071338012	
CHANNNAL	1256	0.0279	0.007206	0.104189364	0.120772167	0.089651318	
CHASBEST	26	0.01793	0.028956	0.10326249	0.138480719	0.076208621	
CHBAICHA	534	-0.12357	0.012192	0.090875716	0.110408925	0.074508821	
CHBEAUCE	44	0.04963	0.027862	0.106235024	0.141531524	0.078931755	
CHBUCKIN	712	-0.13684	0.011202	0.08978532	0.108243135	0.074213029	
CHCHANDL	392	0.10018	0.013981	0.111131117	0.136168329	0.090216698	
CHCHARLV	71	0.10746	0.024536	0.111852281	0.146172075	0.08479024	
CHCHAUVE	411	-0.08451	0.015541	0.094154731	0.117161553	0.075280483	
CHCOMTOI	33	-0.0697	0.027827	0.095425485	0.127620554	0.070694158	
CHDAMQUI	328	-0.20774	0.016123	0.084157143	0.105431002	0.066855113	
CHDOLBEA	408	0.01501	0.014456	0.102992413	0.126888767	0.083167672	
CHFLEURY	1148	0.22903	0.006171	0.124510948	0.142287439	0.108673949	
CHGATINE	1109	0.12013	0.008607	0.113117139	0.132681803	0.096117682	
CHGRANBY	1084	0.11067	0.006891	0.112171564	0.129425785	0.096961376	
CHHDAMOS	370	-0.18577	0.015846	0.085866018	0.107315277	0.068375481	
CHIBOUGA	108	-0.16328	0.027672	0.087647847	0.117465325	0.064843143	
CHJONQUI	896	0.02293	0.00906	0.103726406	0.122396589	0.087619807	
CHLACHIN	679	0.20136	0.009427	0.121525902	0.143347914	0.102627901	
CHLACMEG	252	0.02132	0.018026	0.103576824	0.130681381	0.081566532	
CHLAFLME	22	0.08141	0.029785	0.109290487	0.146822191	0.080448243	
CHLARCHI	210	-0.19305	0.019859	0.085296309	0.109460671	0.066070657	
CHLASALE	464	0.01318	0.013253	0.102823471	0.125581898	0.08379418	
CHLASARE	259	0.0618	0.017739	0.107396105	0.13510325	0.084813964	
CHLAUREN	909	-0.1955	0.009719	0.085105352	0.101406605	0.071216867	
CHLEGARD	1986	-0.11106	0.005589	0.091914562	0.104897913	0.080393847	
CHMANIWA	353	0.19445	0.014989	0.120790136	0.148678064	0.097533914	
CHMATANE	347	-0.17298	0.016138	0.086875276	0.108765871	0.069049116	
CHPIEBOU	1947	-0.06297	0.014518	0.096007999	0.118550644	0.077375602	
CHREDELA	2198	-0.02923	0.004626	0.09897649	0.11151683	0.087707134	
CHREOUTA	1208	-0.15886	0.015581	0.08800194	0.109718061	0.070244881	
CHRESEPI	378	-0.17604	0.017617	0.086632839	0.109553494	0.06814065	
CHRGAMIA	741	0.01057	0.009397	0.102582946	0.121441453	0.086365073	
CHRGGRPO	794	-0.06571	0.008931	0.095770456	0.113055735	0.080886939	
CHRGMAUR	1258	0.12701	0.006064	0.113809191	0.130133321	0.09929903	
CHRGRIMO	1000	0.16548	0.007093	0.117747167	0.136005874	0.101651288	
CHROUNOR	506	-0.19142	0.013729	0.085423569	0.105157904	0.069106647	
CHSTEMAR	837	0.111	0.009266	0.112204433	0.132417675	0.094739757	
CHSTEUST	1390	-0.09733	0.00719	0.093066993	0.108075347	0.079956002	
CHSTGEBE	1276	-0.08054	0.007141	0.094493877	0.109649108	0.081242202	
CHSTJOTR	1541	0.01205	0.005624	0.102719274	0.11707949	0.089940967	
CHSTJOTU	207	0.00739	0.021481	0.102290566	0.131842674	0.078761519	
CHSTLAUR	248	-0.05764	0.017493	0.096471589	0.121550647	0.076118621	
CHSTMICH	543	0.03609	0.011303	0.10495625	0.126203648	0.086930146	
CHUNILAV	1116	-0.24072	0.008499	0.081649832	0.096263679	0.069084929	
CHUNSHER	1033	-0.03505	0.010942	0.098458672	0.118214805	0.081698294	
CHVALDOR	620	0.07459	0.011808	0.108628353	0.131034094	0.089658511	
CHVALLEY	1303	0.08314	0.006638	0.109459009	0.126022947	0.094835929	
CHVERDUN	1830	0.17459	0.004672	0.11869684	0.133442358	0.105382565	
CITESANT	2407	-0.13965	0.004893	0.08955594	0.101381584	0.078988448	
CLAUHAUV	219	-0.16009	0.020795	0.087903273	0.11336027	0.067726402	
CONSEILC	21	-0.02168	0.031654	0.099651842	0.135593207	0.072438996	
CSINUULI	4	-0.01146	0.032794	0.100572553	0.137532126	0.072707964	
CSTEMISC	19	-0.01749	0.031055	0.100028406	0.135695774	0.072944902	
CTRSAFAM	184	0.00128	0.020313	0.101730863	0.130245191	0.078892875	
HARGENTE	514	0.30952	0.011071	0.13355341	0.159269943	0.111438808	
HAUTCOTE	117	0.08995	0.023481	0.1101246	0.143179645	0.083953056	

Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate
HAUTSBOI	2	-0.0134	0.032802	0.100397201	0.137307298	0.072574361
HBARMEMO	365	-0.03568	0.014184	0.098402764	0.121140963	0.079546236
HBELLLEC	180	0.18527	0.01891	0.11981861	0.151276743	0.094176335
HBRMISPE	904	0.16339	0.007895	0.117530225	0.136829628	0.100635577
HCHALEMO	2895	0.28603	0.00339	0.130858541	0.144393232	0.118416937
HCHICOUT	1220	-0.08757	0.009843	0.093894069	0.111795203	0.078605666
HCHRIROI	417	-0.09044	0.015315	0.09365018	0.116366101	0.074992314
HCLOUTIE	242	-0.08932	0.019203	0.093745288	0.11950435	0.073077747
HCOMPONT	207	-0.11376	0.020387	0.091689451	0.117811047	0.070894214
HDALMA	679	-0.16237	0.011963	0.087720643	0.106460833	0.072013407
HDARTHAB	1107	0.01059	0.007296	0.102584787	0.119054707	0.088165274
HDEMONTS	288	-0.02322	0.016197	0.099513756	0.124205412	0.079286344
HDGASPE	334	-0.03107	0.016266	0.09881252	0.123411424	0.078676702
HDLEVIS	1572	0.01568	0.005605	0.103054327	0.117429495	0.090258934
HDMONTMA	736	-0.09356	0.009694	0.09338569	0.111055858	0.078279455
HDMTL	869	0.202	0.009158	0.121594243	0.143090867	0.10293912
HDQUEBEC	798	0.20735	0.010159	0.122166829	0.144981502	0.102511892
HDROBERV	508	0.00431	0.014015	0.102008084	0.125310483	0.082629586
HDSHERBR	1315	-0.1004	0.00651	0.092808191	0.107007693	0.080323425
HDSOREL	944	-0.03142	0.00882	0.098781357	0.116421194	0.083561497
HDSTJERO	2006	0.24917	0.004549	0.126723022	0.142088079	0.112801041
HDUCHRRO	179	-0.03092	0.020073	0.098825878	0.126457805	0.076701575
HENFJESU	1931	-0.13231	0.005138	0.090156218	0.102363361	0.079276247
HGENLACH	299	0.34589	0.014793	0.137818405	0.168661809	0.111856464
HGENLAKE	1705	-0.07678	0.006294	0.094816092	0.10902852	0.082285225
HHAUTRIC	2082	0.02661	0.004571	0.104069024	0.117088488	0.092345822
HJEANTAL	1097	0.31966	0.00659	0.134731145	0.154380583	0.11723594
HLAVAL	2135	-0.17309	0.007653	0.08686655	0.101465578	0.074194606
HMAISROS	2061	0.22183	0.014067	0.12372821	0.151212285	0.100647242
HNDEFAT	334	-0.17504	0.016641	0.086711999	0.108939563	0.068670144
HNDLAC	194	0.06894	0.020375	0.108082482	0.138154119	0.083919102
HNDSTECX	383	-0.13978	0.015609	0.089545341	0.111617507	0.071486684
HPROVMAG	417	-0.29991	0.015009	0.077320059	0.096284521	0.061835307
HRELIZMT	507	0.05565	0.011402	0.106807975	0.128478394	0.08842186
HSACCOMT	2444	0.12781	0.006226	0.113889902	0.130453475	0.099189495
HSANTACA	1371	0.21368	0.005589	0.122847297	0.139528675	0.107910157
HSTECROI	1343	0.05283	0.006363	0.106539245	0.122362799	0.092546165
HSTFRAAS	1475	0.13755	0.005962	0.114876555	0.131184099	0.100362036
HSTJOA	215	0.10059	0.016954	0.111171623	0.138999799	0.088343089
HSTJOMAL	137	-0.01842	0.021986	0.099944716	0.129293883	0.076671043
HSTLUC	782	0.29244	0.010355	0.131589306	0.156100901	0.110422996
HSTSACRE	999	-0.14806	0.007345	0.088872588	0.103446707	0.076177287
HSVPSHER	468	0.0694	0.013017	0.108126834	0.13165565	0.088375012
INSTCARM	2317	-0.13751	0.007394	0.08973058	0.1044816	0.076883354
INUNGESH	271	0.19987	0.015565	0.121366923	0.149946611	0.097609005
JGH	1953	-0.2599	0.006743	0.080223147	0.092930086	0.069121309
LEBEL	16	0.0192	0.031915	0.10338015	0.140629725	0.075134499
MGH	1152	-0.01879	0.008804	0.099911437	0.117709367	0.084546718
NOTRDAME	1377	0.03759	0.008004	0.105097244	0.122767747	0.089710035
PAVLEROY	500	-0.22246	0.016256	0.083029526	0.104146259	0.065879565
PORTCART	48	-0.02595	0.030647	0.099269386	0.134441498	0.072527848
REDMEMOR	154	0.10405	0.021455	0.111513975	0.143284037	0.086080428
RESARIYA	1690	0.00347	0.00522	0.101931164	0.115644342	0.089679204
RVH	924	-0.15527	0.010119	0.088290492	0.105502614	0.073655202
STJEANEU	83	0.00908	0.025856	0.102445858	0.135266449	0.076880736
STMARYS	1059	-0.1345	0.006815	0.089976737	0.104133741	0.077577716
THORACIQ	8	-0.0183	0.031889	0.099955511	0.136141739	0.072579415
TULATTAV	8	-0.02963	0.032318	0.098940824	0.135088657	0.071664195

	Include transfers and assign them to receiving (2nd) hospital						
Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate	
BAIEHAHA	6	0.00821	0.028716	0.102610843	0.137476619	0.075810271	
BASSECOT	31	-0.07074	0.026879	0.095565674	0.127176486	0.071171319	
CHANNNAL	922	0.02379	0.007971	0.104054387	0.12153473	0.088833995	
CHASBEST	22	0.03224	0.026637	0.104844795	0.138879544	0.078391532	
CHBAICHA	413	-0.04676	0.012574	0.097658531	0.118811469	0.079930012	
CHBEAUCE	46	-0.05212	0.025193	0.097187218	0.128109457	0.073102994	
CHBUCKIN	661	-0.12973	0.010879	0.090587216	0.10889742	0.075096268	
CHCHANDL	330	0.08628	0.013938	0.110025956	0.13481035	0.089327639	
CHCHARLV	63	0.10431	0.022808	0.111803911	0.144743208	0.085610286	
CHCHAUVE	352	-0.07326	0.015014	0.095348085	0.11817219	0.076549614	
CHCOMTOI	35	-0.11736	0.025001	0.091611445	0.120871127	0.068879801	
CHDAMQUI	264	-0.17668	0.016007	0.086793048	0.108567347	0.069047551	
CHDOLBEA	315	0.07069	0.014537	0.108508635	0.133570674	0.087673185	
CHFLEURY	946	0.1844	0.006243	0.120007832	0.137348275	0.104591214	
CHGATINE	1045	0.04488	0.008276	0.106037028	0.124164623	0.090283184	
CHGRANBY	929	0.11388	0.007031	0.112757784	0.130275175	0.097332258	
CHHDAMOS	343	-0.16307	0.014926	0.087877861	0.109060975	0.070483682	
CHIBOUGA	69	-0.0968	0.026266	0.09333685	0.123911128	0.069706338	
CHJONQUI	771	0.03793	0.009119	0.105380017	0.124372593	0.088992975	
CHLACHIN	544	0.23597	0.009595	0.125561532	0.148199119	0.105951747	
CHLACMEG	177	0.00507	0.018624	0.102322067	0.129633264	0.080234381	
CHLAFLME	17	0.05977	0.027331	0.107456801	0.142710565	0.080098095	
CHLARCHI	173	-0.15662	0.019116	0.088396239	0.112806897	0.068857907	
CHLASALE	386	-0.00423	0.013074	0.101470994	0.123805482	0.082784962	
CHLASARE	224	0.00797	0.017446	0.102588746	0.128991782	0.081086964	
CHLAUREN	730	-0.20035	0.010047	0.084935221	0.101502003	0.070859162	
CHLEGARD	1653	-0.08403	0.005745	0.094423139	0.107914159	0.082462809	
CHMANIWA	302	0.21252	0.014713	0.123009346	0.15103664	0.099572967	
CHMATANE	272	-0.12502	0.01583	0.09097598	0.113530617	0.072535531	
CHPIEBOU	1695	-0.03904	0.013363	0.098340944	0.120339084	0.079998387	
CHREDELA	1723	0.03481	0.00482	0.105086241	0.118587922	0.092959651	
CHREOUTA	1387	-0.26621	0.014187	0.079954456	0.098899556	0.064379179	
CHRESEPI	236	-0.05751	0.017963	0.096715315	0.122219837	0.076071768	
CHRGAMIA	638	0.04616	0.00946	0.106158425	0.125652093	0.089379852	
CHRGGRPO	668	-0.02444	0.009005	0.099643139	0.117615982	0.084154787	
CHRGMAUR	1082	0.16869	0.006175	0.118358642	0.135398443	0.103207305	
CHRGRIMO	892	0.15565	0.007155	0.117004677	0.135250059	0.100933331	
CHROUNOR	372	-0.07101	0.013733	0.095542339	0.117317902	0.077453913	
CHSTEMAR	649	0.17394	0.009556	0.118907577	0.140491153	0.10025311	
CHSTEUST	1136	-0.09151	0.007517	0.093785481	0.109258974	0.08030581	
CHSTGEBE	982	-0.02229	0.007513	0.099836191	0.116175352	0.085572515	
CHSTJOTR	1125	0.18208	0.00585	0.119763042	0.136488739	0.104838116	
CHSTJOTU	161	0.02636	0.020957	0.104294224	0.13392913	0.080606417	
CHSTLAUR	213	-0.16443	0.016864	0.087768911	0.110400418	0.06941474	
CHSTMICH	469	-0.01489	0.01103	0.100503193	0.120701981	0.083364094	
CHUNILAV	867	-0.23116	0.00877	0.08257105	0.097583709	0.069689637	
CHUNSHER	1717	0.03877	0.008439	0.105459235	0.123690973	0.089639917	
CHVALDOR	548	0.03737	0.011852	0.105327235	0.127193216	0.086846238	
CHVALLEY	1124	0.05929	0.006874	0.107410773	0.124013179	0.09279558	
CHVERDUN	1538	0.11534	0.004773	0.112903931	0.127193351	0.100035848	
CITESANT	1823	-0.11538	0.005079	0.091776352	0.104102271	0.080778259	
CLAUHAUV	182	-0.17417	0.020064	0.086992197	0.111719431	0.067323126	
CONSEILC	17	0.00871	0.028482	0.102656893	0.137375146	0.075940412	
CSINUULI	2	-0.00787	0.02948	0.1011396	0.136096241	0.074388522	
CSTEMISC	19	-0.01841	0.02795	0.100185425	0.133832623	0.074272183	
CTRSAFAM	146	-0.02421	0.019954	0.099663776	0.127405162	0.07742686	
HARGENTE	410	0.21006	0.011854	0.122744212	0.147631594	0.101552432	
HAUTCOTE	80	0.07989	0.022972	0.109401803	0.141875623	0.083636451	

Hospital ID	# AMI index Admissions 1992-1999	Emprical Bayes (EB) estimate of each hospital's deviation from overall intercept	Variance of EB estimate	EB Death Rate	UCL EB Death Rate	LCL EB Death Rate
HAUTSBOI	2	-0.01243	0.029411	0.100725802	0.135514821	0.074102185
HBARMEMO	339	-0.10057	0.013978	0.093018302	0.114497939	0.075225891
HBELLLEC	154	0.1039	0.01807	0.111763203	0.140712641	0.088158616
HBRMISPE	806	0.10691	0.008113	0.112062361	0.130868151	0.095661528
HCHALEMO	2488	0.24248	0.003502	0.126278047	0.139639461	0.114025679
HCHICOUT	1747	-0.08421	0.008542	0.094407748	0.111074031	0.080017082
HCHRIROI	337	-0.11244	0.014878	0.092021705	0.114039832	0.073900109
HCLOUTIE	233	-0.0957	0.017884	0.093429979	0.118121233	0.073470025
HCOMPONT	182	-0.08572	0.019269	0.09427873	0.120214248	0.07347137
HDALMA	555	-0.098	0.011916	0.093235349	0.112965486	0.076653419
HDARTHAB	825	0.09916	0.007648	0.111293518	0.129409669	0.095435449
HDEMONTS	245	-0.04588	0.015969	0.097736105	0.121857803	0.077965352
HDGASPE	309	-0.03353	0.0154	0.098830598	0.12270541	0.07918184
HDLEVIS	1244	0.09603	0.00582	0.110984314	0.12661785	0.097066527
HDMONTMA	597	-0.04662	0.009993	0.097670869	0.116351394	0.081712211
HDMTL	1585	0.14019	0.007636	0.115416866	0.134087308	0.099048745
HDQUEBEC	1484	0.18532	0.008199	0.120105023	0.140160051	0.102577263
HDROBERV	377	0.05793	0.014437	0.107280454	0.132007535	0.086722376
HDSHERBR	1074	-0.12033	0.006717	0.091364585	0.105604255	0.078875662
HDSOREL	861	-0.03518	0.008687	0.098683741	0.116165287	0.083584177
HDSTJERO	1847	0.2251	0.004576	0.1243729	0.139545555	0.110637834
HDUCHRRO	160	-0.05491	0.019087	0.096942693	0.123371755	0.075686521
HENFJESU	1508	-0.08243	0.005344	0.094560039	0.107560545	0.082984751
HGENLACH	239	0.2862	0.01505	0.131181088	0.161094589	0.106119551
HGENLAKE	1286	-0.05438	0.006697	0.096989102	0.111973534	0.083820631
HHAUTRIC	1794	0.00282	0.004737	0.102115584	0.115164797	0.090393913
HJEANTAL	947	0.21597	0.006567	0.12338201	0.141613442	0.107204572
HLAVAL	4978	-0.3157	0.00585	0.076388738	0.087660176	0.066461016
HMAISROS	1736	0.30524	0.012908	0.133366406	0.16126663	0.109662003
HNDEFAT	267	-0.1572	0.016642	0.088349512	0.110946589	0.069992563
HNDLAC	164	0.02868	0.019598	0.104511151	0.133115336	0.081475816
HNDSTECX	335	-0.10801	0.01501	0.092392518	0.114595507	0.074131203
HPROVMAG	268	-0.25588	0.016124	0.080717654	0.101218848	0.064072821
HRELIZMT	477	-0.02961	0.010887	0.099180275	0.119007976	0.082347253
HSACCOMT	3321	0.19347	0.005453	0.120968984	0.137222763	0.106403003
HSANTACA	1236	0.11777	0.005559	0.11314754	0.128660902	0.099291558
HSTECROI	1149	0.09669	0.006429	0.111049451	0.127537287	0.096457483
HSTFRAAS	1302	0.08528	0.005889	0.109928074	0.125530797	0.096051659
HSTJOA	184	0.07376	0.016293	0.108805967	0.135542876	0.086813475
HSTJOMAL	115	-0.02512	0.021026	0.09958215	0.128121702	0.076839608
HSTLUC	1333	0.20972	0.008769	0.122707606	0.143872005	0.104277395
HSTSACRE	823	-0.1735	0.007477	0.087045426	0.101490189	0.074486108
HSVPSHER	432	0.03129	0.012327	0.104755669	0.126988407	0.086031786
INSTCARM	4906	-0.20355	0.005678	0.084686843	0.096859637	0.073918651
INUNGESH	217	0.16274	0.015038	0.117739168	0.145087498	0.094973195
JGH	2208	-0.13365	0.006189	0.0902648	0.103752122	0.078377444
LEBEL	9	0.00346	0.029027	0.102174279	0.137126447	0.075353069
MGH	2059	-0.02974	0.007232	0.099168661	0.115085539	0.085241111
NOTRDAME	2089	0.15196	0.006598	0.116623984	0.13405294	0.101196249
PAVLEROY	371	-0.15775	0.016451	0.088305223	0.110748961	0.070051505
PORTCART	27	0.00305	0.028316	0.102136674	0.136591905	0.075611627
REDMEMOR	140	0.06295	0.019798	0.107762175	0.13728522	0.083970077
RESARIYA	1363	0.04108	0.005459	0.105677353	0.12016577	0.092751654
RVH	1970	-0.15257	0.007806	0.088723142	0.103757282	0.075683451
STJEANEU	55	0.02451	0.024505	0.104121529	0.136410812	0.078778105
STMARYS	909	-0.19216	0.006785	0.085573925	0.099081806	0.073756818
THORACIQ	11	-0.03767	0.028255	0.098462489	0.131819599	0.072838252
TULATTAV	4	-0.01594	0.029293	0.100408311	0.135025296	0.073907906

Appendix 18: Full hospital names corresponding to hospital identifiers used in caterpillar plots and other lists

Hospital ID	Hospital names (Full)
BAIEHAHA	Hôpital de la Baie des Ha! Ha! Inc.
BASSECOT	Centre de santé de la Basse Côte Nord
CHANNNAL	Centre hospitalier Anna-Laberge
CHASBEST	Centre hospitalier d'Asbestos
CHBAICHA	Centre hospitalier Baie-des-Chaleurs
CHBEAUCE	Centre hospitalier de Beauceville
CHBUCKIN	Centre hospitalier de Buckingham
CHCHANDL	Centre hospitalier de Chandler
CHCHARLV	Centre hospitalier de Charlevoix
CHCHAUVE	Centre hospitalier Chauveau
CHCOMTOI	Centre hospitalier Comtois
CHDAMQUI	Centre hospitalier d'Amqui
CHDOLBEA	Centre hospitalier de Dolbeau
CHFLEURY	Centre hospitalier Fleury
CHGATINE	Centre Hospitalier de Gatineau
CHGRANBY	Centre hospitalier de Granby
CHHDAMOS	Centre hospitalier Hôtel-Dieu d'Amos
CHIBOUGA	Hôpital Chibougamau Limitée
CHJONQUI	Centre hospitalier Jonquière
CHLACHIN	Centre hospitalier de Lachine
CHLACMEG	Centre hospitalier Lac-Mégantic
CHLAFLME	Centre hospitalier Laflèche-Grand-Mère
CHLARCHI	Centre hospitalier de L'Archipel
CHLASALE	Centre hospitalier de Lasalle
CHLASARE	Centre hospitalier La Sarre
CHLAUREN	Centre hospitalier Laurentien
CHLEGARD	Centre hospitalier le Gardeur
CHMANIWA	Centre hospitalier de Maniwaki
CHMATANE	Centre hospitalier de Matane
CHPIEBOU	Centre hospitalier Pierre-Boucher
CHREDELA	Centre hospitalier Régional Delanaudière
CHREOUTA	Centre hospitalier Régional de l'Outaouais
CHRESEPI	Centre hospitalier régional de Sept-Iles
CHRGAMIA	Centre hospitalier de la région de l'Amiante
CHRGGRPO	Centre hospitalier régional du Grand-Portage
CHRGMAUR	Centre hospitalier régional de la Mauricie
CHRGRIMO	Centre hospitalier régional de Rimouski
CHROUNOR	Centre hospitalier Rouyn-Noranda
CHSTEMAR	Centre hospitalier Sainte-Marie
CHSTEUST	Centre hospitalier Saint-Eustache
CHSTGEBE	Centre hospitalier Saint-Georges de Beauce
CHSTJOTR	CH St-Joseph de Trois-Rivières
CHSTJOTU	Centre hospitalier Saint-Joseph de la Tuque
CHSTLAUR	Centre hospitalier de Saint-Laurent
CHSTMICH	Centre hospitalier Saint-Michel

Hospital ID	Hospital names (Full)
CHUNILAV	Centre hospitalier de l'Université Laval
CHUNSHER	CH Universitaire de Sherbrooke
CHVALDOR	Centre hospitalier de Val-d'Or
CHVALLEY	CH régional du Suroît à Salaberry-de-Valleyfield
CHVERDUN	Centre hospitalier de Verdun
CITESANT	Cité de la santé de Laval
CLAUHAUV	C.H. Laurentides et C.R. Hautes-Vallées
CONSEILC	Conseil Cri de la santé et des services sociaux
CSINUULI	Centre de santé Inuulitsivik
CSTEMISC	Centre de santé de Témiscaming
CTRSAFAM	Centre de santé Sainte-Famille
HARGENTE	Hôpital d'Argenteuil
HAUTCOTE	Centre de santé de la Haute Côte-Nord
HAUTSBOI	Centre de santé des Hauts Bois
HBARMEMO	Hôpital Barrie Memorial
HBELLLEC	Hôpital Bellechasse (1986)
HBRMISPE	Hôpital Brome-Missisquoi-Perkins
HCHALEMO	Hôpital Charles Lemoyne
HCHICOUT	Hôpital de Chicoutimi Inc
HCHRIROI	Hôpital Christ-Roi
HCLOUTIE	Hôpital Cloutier
HCOMPONT	l'Hôpital communautaire du Pontiac Inc
HDALMA	Hôtel Dieu d'Alma (1964)
HDARTHAB	Hôtel-Dieu d'Arthabaska
HDEMONTS	Hôpital des Monts
HDGASPE	Hôtel-Dieu de Gaspé
HDLEVIS	Hôtel Dieu de Lévis
HDMONTMA	Hôtel-Dieu de Montmagny
HDMTL	Hôtel-Dieu de Montréal
HDQUEBEC	Hôtel-Dieu de Québec
HDROBERV	Hôtel-Dieu de Roberval
HDSHERBR	Hôtel-Dieu de Sherbrooke
HDSOREL	Hôtel-Dieu de Sorel
HDSTJERO	Hôtel-Dieu de St-Jérôme
HDUCHRRO	Hôpital du Christ-Roi
HENFJESU	Pavillon Enfant Jésus (CHA de Québec)
HGENLACH	Hôpital général de Lachine
HGENLAKE	Hôpital général du Lakeshore
HHAUTRIC	Hôpital du Haut-Richelieu
HJEANTAL	Hôpital Jean-Talon
HLAVAL	Hôpital Laval
HMAISROS	Hôpital Maisonneuve-Rosemont
HNDEFAT	Hôpital de Notre-Dame-de-Fatima
HNDLAC	Hôpital Notre-Dame-du-Lac
HNDSTECX	Hôpital Notre-Dame de Ste-Croix (Mont-Laurier)
HPROVMAG	Hôpital la Providence de Magog
HRELIZMT	Hôpital Reine Elizabeth de Montréal
HSACCOMT	Hôpital du Sacré-Cœur de Montréal

Hospital ID	Hospital names (Full)
HSANTACA	Hôpital Santa Cabrini
HSTECROI	Hôpital Ste-Croix (Drummondville)
HSTFRAAS	Hôpital Saint-François d'Assise
HSTJOA	Hôpital Sainte-Jeanne-D'Arc
HSTJOMAL	Centre hospitalier St-Joseph de La Malbaie
HSTLUC	Hôpital Saint-Luc
HSTSACRE	Hôpital du Saint-Sacrement
HSVPSHER	Hôpital de St-Vincent de Paul de Sherbrooke
INSTCARM	Institut de Cardiologie de Montréal
INUNGESH	Institut universitaire de Gériatrie de Sherbrooke
JGH	L'Hôpital Général Juif Sir Mortimer B. Davis
LEBEL	Centre de santé Lebel
MGH	Hôpital général de Montréal
NOTRDAME	Hôpital Notre Dame
PAVLEROY	Pavillon Le Royer
PORTCART	Centre de santé de Port-Cartier
REDMEMOR	Hôpital Reddy Memorial
RESARIYA	Réseau santé Richelieu - Yamaska
RVH	Hôpital Royal Victoria (inclus Hôpital neurologique de Montréal)
STJEANEU	Centre de santé Saint-Jean-Eudes
STMARYS	Centre hospitalier de St. Mary
THORACIQ	Centre hospitaler Thoracique de Montréal
TULATTAV	Centre de santé Tulattavik de l'Ungava

Appendix 19: Hospital outlier status, for each of six HLM analyses

Six HLM analyses, according to 3 ways to define outcome and 3 ways to handle transfers

	Transfers Excluded						Death at 30 days post AMI admission					
Hospital ID N=116	In-hospital Death	Death at 7 days post AMI admission	Death at 30 days post AMI admission	# times HIGH outlier	# times LOW outlier	# times ANY type outlier	Exclude Transfers	Include Transfers assign to Hospital 1	Include Transfers assign to Hospital 2	# times HIGH outlier	# times LOW outlier	# times ANY type outlier
BAIEHAHA				0	0	0				0	0	0
BASSECOT				0	0	0				0	0	0
CHANNNAL				0	0	0				0	0	0
CHASBEST				0	0	0				0	0	0
CHBAICHA				0	0	0				0	0	0
CHBEAUCE				0	0	0				0	0	0
CHBUCKIN				0	0	0				0	0	0
CHCHANDL				0	0	0				0	0	0
CHCHARLV				0	0	0				0	0	0
CHCHAUVE				0	0	0				0	0	0
CHCOMTOI				0	0	0				0	0	0
CHDAMQUI				0	0	0				0	0	0
CHDOLBEA				0	0	0				0	0	0
CHFLEURY			H	1	0	1	H	H		2	0	2
CHGATINE				0	0	0				0	0	0
CHGRANBY				0	0	0				0	0	0
CHHDAMOS				0	0	0				0	0	0
CHIBOUGA				0	0	0				0	0	0
CHJONQUI				0	0	0				0	0	0
CHLACHIN				0	0	0				0	0	0
CHLACMEG				0	0	0				0	0	0
CHLAFLME				0	0	0				0	0	0
CHLARCHI				0	0	0				0	0	0
CHLASALE				0	0	0				0	0	0
CHLASARE				0	0	0				0	0	0
CHLAUREN				0	0	0				0	0	0
CHLEGARD				0	0	0				0	0	0
CHMANIWA				0	0	0				0	0	0
CHMATANE				0	0	0				0	0	0
CHPIEBOU				0	0	0				0	0	0
CHREDELA				0	0	0				0	0	0
CHREOUTA				0	0	0				0	0	0
CHRESEPI				0	0	0				0	0	0
CHRGAMIA				0	0	0				0	0	0
CHRGGRPO				0	0	0				0	0	0
CHRGMAUR				0	0	0				0	0	0
CHRGRIMO				0	0	0				0	0	0
CHROUNOR				0	0	0				0	0	0
CHSTEMAR				0	0	0				0	0	0
CHSTEUST				0	0	0				0	0	0
CHSTGEBE				0	0	0				0	0	0
CHSTJOTR				0	0	0				0	0	0

Six HLM analyses, according to 3 ways to define outcome and 3 ways to handle transfers

Hospital ID N=116	Transfers Excluded			# times HIGH outlier	# times LOW outlier	# times ANY type outlier	Death at 30 days post AMI admission			# times HIGH outlier	# times LOW outlier	# times ANY type outlier
	In-hospital Death	Death at 7 days post AMI admission	Death at 30 days post AMI admission				Exclude Transfers	Include Transfers assign to Hospital 1	Include Transfers assign to Hospital 2			
CHSTJOTU				0	0	0				0	0	0
CHSTLAUR				0	0	0				0	0	0
CHSTMICH				0	0	0				0	0	0
CHUNILAV				0	0	0		L		0	1	1
CHUNSHER				0	0	0				0	0	0
CHVALDOR				0	0	0				0	0	0
CHVALLEY				0	0	0				0	0	0
CHVERDUN				0	0	0				0	0	0
CITESANT				0	0	0				0	0	0
CLAUHAUV				0	0	0				0	0	0
CONSEILC				0	0	0				0	0	0
CSINUULI				0	0	0				0	0	0
CSTEMISC				0	0	0				0	0	0
CTRSAFAM				0	0	0				0	0	0
HARGENTE				0	0	0		H		1	0	1
HAUTCOTE				0	0	0				0	0	0
HAUTSBOI				0	0	0				0	0	0
HBARMEMO				0	0	0				0	0	0
HBELLLEC				0	0	0				0	0	0
HBRMISPE				0	0	0				0	0	0
HCHALEMO	H	H	H	3	0	3	H	H	H	3	0	3
HCHICOUT				0	0	0				0	0	0
HCHRIROI				0	0	0				0	0	0
HCLOUTIE				0	0	0				0	0	0
HCOMPONT				0	0	0				0	0	0
HDALMA				0	0	0				0	0	0
HDARTHAB				0	0	0				0	0	0
HDEMONTS				0	0	0				0	0	0
HDGASPE				0	0	0				0	0	0
HDLEVIS				0	0	0				0	0	0
HDMONTMA				0	0	0				0	0	0
HDMTL	H			1	0	1				0	0	0
HDQUEBEC		H		1	0	1				0	0	0
HDROBERV				0	0	0				0	0	0
HDSHERBR				0	0	0				0	0	0
HDSOREL				0	0	0				0	0	0
HDSTJERO			H	1	0	1	H	H	H	3	0	3
HDUCHRRO				0	0	0				0	0	0
HENFJESU				0	0	0				0	0	0
HGENLACH				0	0	0		H		1	0	1
HGENLAKE				0	0	0				0	0	0
HHAUTRIC				0	0	0				0	0	0
HJEANTAL	H		H	2	0	2	H	H	H	3	0	3
HLAVAL				0	0	0			L	0	1	1
HMAISROS				0	0	0			H	1	0	1

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Hospital ID N=116	Transfers Excluded			# times HIGH outlier	# times LOW outlier	# times ANY type outlier	Death at 30 days post AMI admission			# times HIGH outlier	# times LOW outlier	# times ANY type outlier
	In-hospital Death	Death at 7 days post AMI admission	Death at 30 days post AMI admission				Exclude Transfers	Include Transfers assign to Hospital 1	Include Transfers assign to Hospital 2			
HNDEFAT				0	0	0				0	0	0
HNDLAC				0	0	0				0	0	0
HNDSTECX				0	0	0				0	0	0
HPROVMAG	L			0	1	1		L		0	1	1
HRELIZMT				0	0	0				0	0	0
HSACCOMT				0	0	0				0	0	0
HSANTACA	H			1	0	1		H		1	0	1
HSTECROI				0	0	0				0	0	0
HSTFRAAS				0	0	0				0	0	0
HSTJOA				0	0	0				0	0	0
HSTJOMAL				0	0	0				0	0	0
HSTLUC	H		H	2	0	2	H	H		2	0	2
HSTSACRE				0	0	0				0	0	0
HSVPSHER				0	0	0				0	0	0
INSTCARM				0	0	0			L	0	1	1
INUNGESH				0	0	0				0	0	0
JGH	L	L	L	0	3	3	L	L		0	2	2
LEBEL				0	0	0				0	0	0
MGH				0	0	0				0	0	0
NOTRDAME				0	0	0				0	0	0
PAVLEROY				0	0	0				0	0	0
PORTCART				0	0	0				0	0	0
REDMEMOR				0	0	0				0	0	0
RESARIYA				0	0	0				0	0	0
RVH				0	0	0				0	0	0
STJEANEU				0	0	0				0	0	0
STMARYS				0	0	0				0	0	0
THORACIQ				0	0	0				0	0	0
TULATTAV				0	0	0				0	0	0
# high outliers	**5**	**2**	**5**				**5**	**8**	**4**			
# low outliers	**2**	**1**	**1**				**1**	**3**	**2**			

Legend for Significant Outlier Status
H = High outlier (worst performer)
L = Low outlier (best performer)
Shaded cell = not an outlier