IMPACT OF THE CONSULTANT'S TYPE OF SPECIALTY ON THE NUMBER OF REFERRALS AFTER A FIRST CONSULTATION

PRESENTED BY:
PIERRE COSSETTE

DEPARTMENT OF EPIDEMIOLOGY AND BIOSTATISTICS
MCGILL UNIVERSITY
MONTREAL

September 1998

A thesis submitted to the Faculty of
Graduate Studies and Research
in partial fulfilment of the requirements of the degree of
Master's in Science

0-612-50741-6

Table of contents

Abstract

A debate is presently taking place about the respective training and roles of general internists and medical subspecialists in the provision of specialized care in Canada. However, very little evidence is available in the literature to document expected differences in the impact of generalized and subspecialized internal medicine care on utilization of health care resources and on outcomes of care.

Our goal was to describe and compare the number of subsequent referrals for consultation to specialists, between patients referred initially to general internists, in comparison to patients referred initially to cardiologists, pneumologists, gastroenterologists, endocrinologists, or rheumatologists. We also compared measures of continuity of care and of professionnal charges between these two groups of patients, following their initial referral.

Administrative databases from the "Régie de l'assurance maladie du Québec" were used to identify the study population and to measure the outcomes. Information on known determinants of referral, including case-mix characteristics, was gathered and included in the multivariate analysis.

Résumé

Un débat se déroule actuellement concernant la formation et les champs d'action professionnels respectifs des internistes généraux et surspécialisés, dans la prestation de soins médicaux spécialisés au Canada. Toutefois, très peu de données sont disponibles dans la littérature permettant d'évaluer l'impact de ces deux types de soins sur le niveau d'utilisation des ressources, ainsi que leurs conséquences sur la santé.

Notre objectif est de décrire et de comparer des patients référés initialement en médecine interne générale, avec des patients référés initialement en cardiologie, pneumologie, gastroentérologie, rhumatologie ou endocrinologie, quant au nombre de consultations spécialisées qu'ils ont obtenues subséquemment. Nous avons aussi comparé des mesures de continuité des soins et d'honoraires professionnels pour ces groupes de patients, pour la même période.

Des données de facturation de la Régie de l'Assurance Maladie du Quebec ont été utilisées pour identifier la population éligible et pour comptabiliser les résultats. Des données sur les déterminants connus de l'utilisation des consultations spécialisées, comprenant la sévérité et les types de pathologie rencontrés, ont été incluses dans l'analyse multivariée.

Introduction

An extensive debate on the respective roles of internal medicine generalists and subspecialists in the delivery of health care has been taking place in the past 20 years. This debate has been driven by growing budgetary pressures to control the use of health services and increasing fragmentation of medical knowledge. (1-8) The lack of objective data to describe and compare practice patterns has prompted many authors to request that research in this area be intensified.(1,5,6,9-13) In recent years, efforts have been made in the U.S. to provide new evidence on the advantages and disadvantages of various structures of care involving different mixes of physician specialities. The impact of these mixes on human resource needs, costs, and quality of care - notably in the field of primary care - have been reported. However, data are still insufficient and of unequal methodological value.(12,14)

Provincial governments in Canada, and particularly the Quebec government, with the co-operation of medical faculties and other medical authorities, are presently adapting physician training to increase the number of general internists, and the structure of care to institute a second line of medical intervention between general practitioners and subspecialists. While increasing the number of general internists will provide greater access to specialized care in rural and remote areas, it is also assumed that increasing the use of general internists will lower costs related to the use of subspeciality care and technical resources, without compromising outcomes. Most of the evidence supporting these assumptions is weak, and may not be generalizable directly to the Canadian context. Even if the assumption of a decrease in the use of technical resources is likely to apply here, we are not certain of its impact on outcomes of care. The assumption about a decrease in subspeciality physician resources use is not documented by any study. This last assumption is crucial because, without this effect, no gain in continuity of care should be expected which would limit any potential gain in quality of care. Cost savings through lesser technology-use could be more than offset by an increase in physician-resource use.

The debate about the role of general internists and their training requirements, when compared to medical subspecialists, is presently ongoing at the political level, with seemingly little empirical information, and with potentially important impacts on the delivery of health care in Quebec and Canada.

Principal research objective

The primary objective of this study is to determine if there are differences in the number of subsequent consultations to specialists, between patients seen initially in consultation by general internists and by medical subspecialists.

Secondary research objectives

1- To determine if there are differences in the continuity of the care received by patients seen initially in consultation by general internists and by medical subspecialists.

2- To determine if there are differences in the professional charges generated for patients seen initially in consultation by general internists and by medical subspecialists.

Hypotheses

1- Patients referred initially to general internists will have a smaller number of subsequent referrals for consultation to other specialists than comparable patients referred initially to medical subspecialists.

2- Continuity of care will improve with a smaller number of subsequent referrals and will be higher for general internists' patients.

3- Professional charges will increase with a higher number of subsequent referrals and will be lower for general internists' patients.

LITERATURE REVIEW

A) Introduction

There has been an extensive debate on the respective roles of internal medicine generalists and subspecialists in the delivery of health care in the past 20 years. This debate has been driven by growing budgetary pressures to control the use of health services and by increasing fragmentation of medical knowledge. (1-8)

The lack of objective data to describe and compare practice patterns has prompted many authors to request that research in this area be intensified.(1,5,6,9-13) In recent years, efforts have been made in the U.S. to provide new evidence on the advantages and disadvantages of various structures of care involving different mixes of physician specialities. The impact of these mixes on human resource needs, costs, and quality of care - notably in the field of primary care - have been reported. However, data are still insufficient and of unequal methodological value.(12,14)

B) General versus subspecialized internal medicine in Canada

In Canada, most of controversy about the specific roles of general internists and medical subspecialists concerns the delivery of secondary[1] care. Pressures to contain costs and to improve the access to specialized care in medium and small size communities, notably in remote areas, have fueled the discussion of medical manpower priorities in this country.(7,8,16-18) Provincial governments, and particularly the Quebec government, with the co-operation of medical faculties and other medical authorities, are presently adapting physician training to increase the number of general internists, and the structure

[1] In this discussion, we will use the levels of care classification of the Canadian Medical Association (CMA) and the Royal College of Physicians and Surgeons of Canada (RCPSC). *"Primary care is considered to be the medical service that results from "first contact" or "ongoing direct contact" between a patient and a provider of medical care. ... Secondary care is considered to be the medical service that is rendered when a patient is referred by a primary care provider to a second physician (in most intances a specialist), who generally acts as a consultant. Tertiary care is considered to be the medical service that results when a consulting specialist refers a patient to another specialist, most often because of the need for medical technology or facilities usually located in university health centers."* (15)

of care to institute a second line of medical intervention between general practitioners and subspecialists.(29-32,102)

These policy changes have been guided by assumptions about the potential benefits of general internists as second line care providers. It is assumed that general internal medicine care, as opposed to subspecialized care, could have three major impacts on the process of care: (7,8,16-18)

1- a decreased use of subspeciality consultations.
2- a decreased use of diagnostic tests and technical resources;
3- an improved geographical access to specialized care in medium and small communities;

In this literature review, we will describe and analyze the evidence that supports each of these assumptions and their potential consequences on quality of care. However, important clarifications must be made in order to interpret the data presented. First, because many studies were carried out in the United States, the differences between American and Canadian health care systems in relationship to the roles of general internists and subspecialists will be clarified. Second, important differences between general and subspecialized internal medicine training and practice patterns in Canada will be described. Finally, to aid in interpretation of studies of quality of care, a framework for the analysis of quality of care will be presented.

1- Differences between Canadian and American system of care

Three major elements of the structure of care related to physician manpower differ between Canada and the United States in relationship to the roles of general internists and subspecialists.

1- In Canada, subspecialists and general internists act most often as secondary and tertiary care providers, even if they provide some primary care, especially for patients with chronic, complex or difficult medical problems. The role of primary care provider in adult medicine has been exercised mainly by general practitioners or family physicians in this country. In the United States, not only are general internists considered primary care providers, but also an important percentage of subspecialists contribute significantly to primary care.(4,7,15,16)

2- The utilization of specialists in primary care in the United States is partly due to the insufficient number of general practitioners and family physicians trained in medical schools. In the U.S., only 11.5% of physicians are generalists, if only general practitioners and family physicians are considered. In 1989, specialists represented 63% of all active American physicians even when accounting for general internists and pediatricians as generalists in these statistics.(3) In Canada, provincial government policies have ensured that, over the years, from 50% to 60% of medical school graduates obtain training in general medicine programs (previously through multidisciplinary internship and now through family medicine residencies). In the United States, the lack of policies regarding speciality training in the 1970's and 1980's has led to the increased production of subspecialists.(4)

3- In the United States, methods of physicians remuneration differs from one study to another and often within one study population.(5,6,19) Many of these payment structures contain incentives that can influence the process of care.(6,14,20) In Canada, the population of each province is covered by universal provincial health insurance plans.

Globally, these differences represent very important limitations in the generalizability of American-based findings to Canadian situations. American-based evidence is used in this discussion as it is often the only data available, even if it has to be interpreted very cautiously in the Canadian context.

2- Comparison between general and subspecialized internal medicine in Canada

2.1- Origin and evolution of subspecialized and general internal medicine training programs in Canada

The progressive increase in medical knowledge during the 20th century has led to the differentiation and standardization of specialized medical care. Scientific development not only expanded the knowledge base, but also gave rise to non-surgical technologies, or procedures requiring special abilities and skills. Under these pressures, the internal medicine field has been subdivided progressively into various medical subspecialities. Training programs centered on one organ or system have evolved to allow enough time for the acquisition of technical skills and for the refinement of speciality expertise.(3,7,18) Because of the increasing fragmentation of the internal medicine field into highly focused subspecialities, general internal medicine has re-surfaced in the last decades to fulfil the need for specialized medical care which emphasizes clinical decision-making in the context of the whole patient.(7,8,16,18,21)

In Canada, most of the internal medicine subspeciality training programs require that a candidate spend three years in an internal medicine training core program followed by two to three years in a subspeciality fellowship (total of five to six years). The requirements for a general internal medicine certification are three years of "core" followed by one year of general or subspeciality internal medicine training (total of four years).(7,18) Because the first year spent in a subspeciality training program was recognized as a fourth year of internal medicine training, Canadian medical subspecialists obtained a double certification in both general internal medicine and their subspeciality. However, in recent years, specific general internal medicine programs have been established in Canada, and some of these have extended their training requirements to two years after the three year core training, instead of one year.(8,18) The province of Quebec was the first in Canada to accept this principle in 1995. The training in general internal medicine will be extended from four to five years, and the certification in general internal medicine will no longer be provided for medical subspecialists.(102)

2.2- Comparison of the practice patterns of general internists and subspecialists in Canada

Medical specialists assume different roles depending on the setting, the type, and the geographical location of their practice. In addition to clinical work, they may be involved in medical teaching, research, and administrative duties. The place of general internists in Canada is mainly in secondary care, and even in tertiary care in some instances. Their functions vary with the size of the community and with the hospital's mission (academic vs non-academic setting). In larger communities (population > 250 000), the role of general internists is more often limited to the managament of undifferentiated or complex problems and to some restricted areas of medical practice (pre-operative evaluation for example). In medium- (50 000 to 250 000) and small- (< 50 000) sized communities, however, they provide consultation on a much broader range of issues, and they often fulfil secondary care roles (such as endoscopy) that would otherwise be provided by subspecialists. In these situations, where general internists provide access to specialized care and to basic technical procedures, general internists often hold the role of gatekeeper to subspecialized medical care. Finally, in academic centers, general internists may play a central role as co-ordinators of care in complex situations (intensive care for instance), and as teachers of medical students or residents.(7,16-18)

The place of subspecialists is also mainly in secondary and tertiary care. However, subspecialized care is concentrated to larger- and to certain medium-sized communities, where they provide the major proportion of tertiary care. The subspecialist's geographical reach is limited by the necessity of a large enough population to sustain a viable group practice, and by the concentration of tertiary technologies inside academic tertiary care centers.(15,18) Like general internists, they are involved in teaching, research, and administrative duties. The research interests of internists and subspecialists differ slightly although they overlap. Subspecialized research is more often fundamental and organ-centered, involving applications of new technologies. General internal medicine research is targeted more toward medical education, technology assessment, clinical epidemiology, decision analysis, economic evaluation and bioethics.(7,18) Historically, research has occupied a greater place in subspecialized training than in general internal medicine training, even though this trend may be changing with the development of the new general internal medicine programs.(18)

Many authors and researchers have commented in the past on the different approaches and respective advantages of general and subspecialized internal medicine. According to Braunwald (3) and Robinson (18), the specificity of general internal medicine, relies in its ability, acquired through training and practice, to use an expertise based mainly on a cognitive rather than a technical approach of the patient. Turnbull (cited in (18)), Noble (21) and Contandriopoulos et al (17) state that general internal medicine is not the sum of medical subspecialities, it is rather a different patient approach that relies on the integration of all personal dimensions and health problems. In contrast, subspeciality care applies to a restricted field of medicine, which requires a deeper corpus of knowledge, abilities and technical skills, related to the corresponding subspeciality.(23)

2.3- Overlap between general and subspecialized internal medicine care in Canada

There is no clear dichotomy between general and subspecialized internal medicine. In Canada, no data exist on the exact number of subspecialists and general internists. Subspecialists have an additional certification in general internal medicine, and some of them are in fact providing general internal medicine care to their patients, either through shared "on-call" schedules or inpatient care with internists or other subspecialists, or because they choose to do so for their global practice. The proportion of subspecialists having this type of practice, or the proportion of their practices devoted to general internal medicine is thought to be minor, but no quantification of this phenomenon is available at this time. The Royal College of Physicians and Surgeons of Canada is presently attempting to obtain these data.(7) Furthermore, some internists devote a major part of their practice to only one subspeciality field of interest, including a high proportion of related technical acts (cardiac ultrasounds or vascular Doppler procedures for example). A 1986 survey by the Canadian Society of Internal Medicine revealed that, among its members who did not have a subspeciality certification (≈75% of respondents), close to 10% considered they were practising exclusively one subspeciality.(22) In Quebec, data on technical procedure billings show that only a minority of general internists (≈10%) have a practice profile with a high percentage of technical procedures indicating a subspeciality interest. These 10% were performing 51% of all technical procedures billed by general internists in Quebec.(17) This evidence tends to confirm that only a minority of general internists have in fact a subspecialist-like practice pattern.

3- Quality of care: structure of analysis

Quality of care assessment and outcome research is one of the most rapidly growing area of clinical epidemiology research. Most of the research efforts have taken place in the United States possibly because of the emergence of managed care and incentives to lower the costs attributed to specialized care.(14,24)

In 1980, Donabedian proposed a three-category classification of information from which inferences can be drawn about quality of care.(9,25) This classification has been accepted and used by many authors and it will be used in the present discussion. (12,27,28) According to this method of classification, quality of care can be evaluated on the basis of structure, process, and outcome:

1-Structural data relate to the setting in which care occurs (a hospital or clinic for example). They also include human resources, their training, and the organizational structure. Costs are included in this category.

2-Process data are the components of the encounter between the health professional and the patient. They include prescriptions and recommendations made by the health professional.

3-Outcome data refer to the patient's subsequent health status following health care. Outcome data can be further subdivided into biological health, health behaviours, and patient satisfaction.(9,27)

As outlined previously, it is assumed that general internal medicine care, in comparison to subspecialized care (a modification in structure of care), would have three major impacts on the process of care:

1- a decreased use of subspeciality consultations.
2- a decreased use of diagnostic tests and technical resources;
3- an improved geographical access to specialized care in medium and small communities;

The available evidence concerning each of these assumptions in relationship to outcomes of care, costs (a component in the structure of care), and continuity of care (a component in the process of care) will be described.

4- General versus subspecialized internal medicine

4.1- A decreased use of subspeciality consultations

4.1.1-Subsequent referral definition

Almost all the literature data on the study of referral concern the "primary referral", defined as the initial referral for a consultation requested by a primary care physician. The term "subsequent referrals" or "subsequent consultations" will be used to describe the occurrence of other consultations to specialists for a patient, following his or her primary referral.

4.1.2-Available evidence on subsequent referral use

Referrals from primary care physicians have been the subject of many studies. However, none of these studies examined the impact of the speciality of the consultant on subsequent use of physician resources. No description of the subsequent referral phenomenon was found in these publications. Because of this, the available evidence on primary referral practices will be presented and will be discussed as to how it could apply to subsequent referrals practices.

4.1.3-Rationale for the decreased use of subspeciality consultations for general internal medicine patients

From a theoretical perspective, the versatility of internists should allow them to provide care on a substantial proportion of a patient's problems otherwise necessitating a "array" of subspecialists. Their training and practice should render them especially competent in dealing with undifferentiated or complex illnesses, severe illnesses, chronic diseases, and co-ordination of care in some instances like critical care medicine.(7,49) Internists do play a role as gatekeeper to medical subspecialities in some small- and medium-size communities where they provide internal medicine speciality coverage locally. It is speculated that they also play this role in larger communities because of their broad range of specialized expertise.(7,15,17) By definition, an effective and competent gatekeeper should decrease the need for subsequent referral for patients they see in consultations themselves. Many authors, as well as associations of internists use the gatekeeper function as a strong argument for an increased role of general internal medicine in health care delivery.(7,8,15) Opposing views hypothesize that internists may represent an unnecessary step to subspecialized care that limits or delays access to top quality expertise.(2,6)

4.1.4-Available evidence on referral determinants

Referral and consultation practices of physicians have been studied mostly in the primary care context. Referral practices have to be studied specifically since their relations to other aspects of health care resource use (such as the use of test or hospitalization) is unpredictable.(50,51) Researchers from Canada, the United States and the United Kingdom have tried to explain and analyze referral practices in various settings. The most striking and constant finding of these studies is the important variation of referral practices between physicians. The ratio from higher to lower referral rate among practitioners within relatively homogeneous groups has been found to vary from three to six.(50,52-59) Calman et al (52) found that one given physician could refer very different proportions of his patients in each subspeciality area, implying that physicians who refer a substantial proportion of patients in one speciality area may be low referrers in another speciality area. In opposition, Wilkin and Smith (56) found that higher referrers consulted more for all subgroups of patients than lower referrers. However, this study's sampling procedure was based on referral rates (a group of high referrers was compared to a group of low referrers) and it was likely, by design, that the high referrers as a group would have higher rates on average for a majority of diseases, when compared to a group with much lower rates overall. Actual referral rates reported varied from 1.6 (57) to 16.4 (60) referrals per 100 patients seen.

Determinants of referral practices can be categorized into five groups: patients' characteristics, referring physician's characteristics, health care system characteristics, consulting physician's characteristics, or characteristics of the interactions between the patient and the physicians involved. A summary of the findings in relationship to determinants is presented in table 1.

Patient characteristics : Gender (male (56) or female (58,61)), and older age with the exception of the very young (56,58,61,62) have been associated with higher rates of referral. Data on socio-economic class are contradictory; Wilkin and Smith (56) found higher SES to be associated with lower referrals while Moore and Roland (58) found the inverse relationship. Marital status had no effect.(62) Type and severity of medical condition (often described as the "case-mix" of a medical practice) have a major influence and have been recognized as the principal determinant of a physician's decision to refer.(60,63,64) Patient pressures, demands or need for reassurance have also been identified as important determinants.(63-67)

Primary care physician characteristics: Physician age and number of years in practice were not important in some studies (56,62) while younger age was associated with higher referrals in another one.(68) Interestingly, one American and one British study found that diagnostic certainty and knowledge in specific speciality areas were associated with higher referral rates to these subspecialities.(52,55) No link was found between referral rate and the specificity of the consultation request.(52) These studies show that general practitioners vary in their need for speciality consultation based on their own skill and experience in a particular speciality; higher levels of competence, sensitivity, and diagnostic acumen of a practitioner in a given speciality area would lead to a higher (rather than lower) rate of consultation. However, both studies were carried out in only one practice setting with a few practitioners, which could limit generalizability of these findings. Their conclusions are reinforced by a study done in Quebec which found that family physicians with higher licensure examination scores referred more patients in the first 18 months of their practice.(69) Attitudes toward risk taking have been found to be associated with referral practices in one study (physicians with high risk-taking attitudes refer less) (51), while another study found no association between risk-taking attitudes and referrals.(70)

Table 1: Summary of literature evidence on determinants of referrals from primary care

Determinant category	Associated with increased referral rate	Associated with decreased referral rate	Not associated with referral rate
1-Patient characteristics	Male gender (56) Higher age (56,58,61,62) Higher SES (56) ⇑Severity of medical condition (60,63,64) Patient demand (63-67)	Male gender (58,61) Higher SES (58)	Marital status(62)
2-Primary care physician characteristics	Younger age (68) Group practice (60) Diagnostic certainty (52) ⇑Competence (55,69)	Rural setting (53) High risk-taking attitude (51)	Age,Experience(56,62) Solo vs group(56) Work load (56) Risk-taking attitude(70) Specificity of consult request(52)
3-Health care system characteristics			Financial incentives (71,72)
4-Consulting physician characteristics	⇑expected quality of care (66,74) Positive perception of the referral (66)	⇓Geographical availability (67,74,75) ⇑Waiting time (74)	
5-Interpersonal relationship characteristics	⇓Confidence of patient toward his primary care physician (74)	⇓Quality of communication between primary care physician and consultant (66)	

Access to care and practice organization have also been identified as a referral determinants. Urban setting has been associated with higher referral rates as opposed to rural practice.(53) Workload has not been associated with referral rates.(56) Contradictory evidence has been found on the effect of the type of practice (solo or group).(56,60)

Health care system characteristics: The presence of financial incentives to limit referral have not been found to have a significant impact on referral rates in two British studies.(71,72) These studies demonstrated that the progression in the rates of referral remained very similar for physicians affected and not affected by a reform (implemented in the UK), which penalized groups of general practitioners if they increased their referral rates. One American study showed that patients enrolled in Health Maintenance Organizations were more likely to be referred than patients who paid a fee-for-services. However, some important problems in methodology, particularly with adjustment for other determinants lessened the value of its conclusion.(73)

The comparison of referral rates between countries is very difficult because of important differences in the availability of unreferred access to specialized care, and because denominators used in the calculations of the rates differ from one country to another. American studies usually use the frequency of referral per 100 patients seen, while British studies most often use the number of referrals per 100 patients per year on physicians' capitation lists. American studies reported referral rates generally between 1.5% and 4% (52,57,61,73) of patients seen, while British studies showed rates generally between 7% to 11% per year (53,55,62,71,72). The Canadian study by Tamblyn et al (69) reported an average referral rate of 7.1% of patients seen.

Consulting physician characteristics: Geographical (67,74,75) and organizational availability of the consultants (expected waiting time or restriction of practice) (74) have been reported by primary care physicians to influence their decision to refer a patient. Other factors such as expected level of quality of care from the consultant have also been evoked in some studies.(66,74)

Characteristics of the patient / physician interaction or of the referring / consultant physician interaction: Lack of confidence of the patient in his/her primary care physician, or increased confidence in a consultant on the part of the referring physician would both increase the possibility of referral.(74,76) A qualitative study found that primary care physicians were more likely to refer patients to consultants if they experienced a high quality of communication with these consultants in the past.(66) Muzzin proposes (65) that many non-quantifiable components of interactions between people involved in referral decisions could play a very important role, which could explain in part why so much variability remains unexplained even after the elaboration of complex mathematical models for studying referral rates.

Cummins et al (62) argue that personal physicians' characteristics may play the most important role in explaining these residual variations; they described these as referral threshold variations. However, they did not explore possible reasons for differences in referral threshold. Moore and Roland (77) proposed that chance alone must be an important factor causing this high variability in referral rates. They assumed that referrals were relatively rare events and thus referral rates have many characteristics of the Poisson distribution. When they used mathematical models based on this type of distribution on already published data, they found that much of the variance remaining could be attributed to chance.

4.1.5-Primary referral justification

In sum, there is still a limited understanding of the clinical decision-making processes that govern consultation and referral practices. Investigators have tried to characterize referral decisions according to their justification to improve our comprehension of the phenomenon. They identified that reasons leading to a consultation request can be classified into the following categories:

1-diagnosis or its confirmation;
2-advice on management, either diagnostic or therapeutic;
3-specific investigation procedure;
4-specific treatment or surgical procedure;
5-request for the consultant to take over the management of the patient;
6-reassurance of either the patient, a relative, or the referring physician;
7-specific request by the patient;

8-referring physician's education;
9-medical-legal reasons.(63,78,79)

This type of classification helps us understand the various factors leading to the referral decision. However, it has not been translated into quantifiable characteristics that can be used in a multivariate analysis of different types of practices.

4.1.6-Applications of primary referral evidence to subsequent referrals

4.1.6.1-Referral determinants

The various primary referral determinants identified previously should play a role in subsequent referrals since, by definition, they occur in a subgroup of all the patients receiving a primary referral. In comparison, the population involved in subsequent referrals should be expected, on average, to have more severe, complex, or multifaceted problems than primary care patients who are referred to specialists for the first time. In these circumstances, severity of illness and comorbidity are likely to gain in importance as determinants.(37,54) Characteristics of physicians and interactions between persons involved in the process will likely influence the rate of subsequent referrals for consultation. However, these associations have not been studied.

4.1.6.2-Referral justification

The decision process leading to subsequent referrals can be different from the primary referral decision process. Some of the reasons justifying the request for a subsequent referral have been deduced from clinical experience in the absence of available literature. Factors that may determine the need for subsequent referral include:

1- if the diagnostic problem has not been solved, or the question not answered satisfactorily by the first consultant;

2- if the consultant identified that the problem was not inside his/her speciality area of expertise;

3- if the consultant identified <u>new</u> problems that needed specialized expertise;

4- if the patient had more than one problem and needed simultaneous care from another subspecialist;

5- when either the patient, a relative, or one of the physicians expressed the need for a second opinion for the initial problem, either from the same type, or from another type of specialist.

4.1.6.3-Relationship between referral justification and use of subsequent referrals

Depending on the principal justification for subsequent referrals, general internal medicine care and subspecialized internal medicine care could have different impacts on subsequent referral decision processes. It was postulated that initial referral to general internists, in comparison with subspecialists, should decrease the number of subsequent referrals for these patients. One of the principal arguments supporting that assumption is that the broader field of competence of general internists should allow them to manage a greater proportion of a patients' problems. A broader field of competence should be advantageous for: a) patients experiencing many different problems; b) patients experiencing non-differentiated problems; c) for patients referred to the wrong subspecialist because of misinterpreted symptoms. However, the more limited depth in expertise of general internists would be a disadvantage for: a) patients presenting with a single circumscribed problem; b) patients requiring technical expertise for their investigation or treatment. Depending on the population of patients referred, general internist may decrease or increase the use of subsequent referrals.

Differences in the approach to medical care by general internists and medical subspecialists should also affect the probability that the consultant will identify new problems. The subspecialist, being system or organ oriented, should be less likely to detect pathologies not directly related to the reason of consultation than the general internist. This phenomenon should result in fewer subsequent referrals asked directly (or on their recommendation) by subspecialists. This phenomenon should be lessened by the fact that undetected problems due to the narrower expertise area of subspecialists should manifest themselves over time, and then possibly could be the subject of another referral. If so, it may result in another referral by the primary care practitioner. Also, one could suppose that internists should be able to manage a fair percentage of the new problems they detect when they fall within their area of expertise (the broad field of internal medicine), while they would have to refer their patient for the problems outside the discipline (orthopedic or surgical problems for example).

4.1.7-Summary of the evidence on the decreased use of subsequent consultations by general internists' patients

No direct evidence was available in the literature with regards to the decrease in the use of subspeciality consultations by general internists' patients, when compared to medical subspecialists' patients. From the literature on primary referrals, we found that many referral determinants have been identified, but their role in subsequent referrals is uncertain - especially for physicians' characteristics. Both general or subspecialized internal medicine care could reduce the need for subsequent referrals depending on the reasons for the primary referral, the severity and the differentiation of disease, the presence of comorbidity, and the availability of other types of consultants.

4.1.8-Potential impact of referral practices on quality of care

4.1.8.1-Appropriateness of referrals

Under-referral as well as over-referral may have a negative impact on patient health. Appropriate consultation and referral may lead to prompt diagnosis and treatment of conditions that were beyond the immediate expertise of the primary-care physician. Inappropriate referral may lead to unnecessary testing and a cascade of increasingly expensive, invasive, and risky procedures in an often futile search for diagnostic certainty.(46,47,79)

Researchers have tried to evaluate directly the appropriateness of the consultations in only a few publications. Their findings demonstrate that there is approximately the same proportion of appropriate referrals among practitioners with high- and low-referral rates (55% to 60% of clearly appropriate and 15 to 20% of unjustified referrals).(80) Coulter et al (81) found that the same proportion of patients referred from primary care physicians to specialists were hospitalized or were getting various surgical interventions, whether they were sent by high or low referrers. They concluded that the proportion of appropriate referrals was probably similar whatever the observed rate. Consequently, no accepted general guidelines exist on referral and no "target rate" is currently accepted, either for primary or secondary referrals. (10,82)

Based on the potential link between broader competence, diagnostic acumen, and higher referral rates, found in primary care, one could argue that the more "competent" specialists should refer more. This is not the subject of the actual discussion. Stronger and weaker candidates are present in the distribution of each speciality and the expertise expected from a subspecialist and from an internist are not the same. By definition, a particular subspecialist will be "incompetent" in areas for which an internist is competent, and vice versa. The object of the actual debate is to determine if differences in type of approach and in training between internists and subspecialists do result in differences in use of subsequent referrals - considering that the proportion of "appropriate" referrals are similar, relative to each speciality's specific expertise.

4.1.8.2-Potential impact of a decreased use of subsequent referrals on outcomes of care

Studies to date have not examined referral rate as a endpoint in comparisons of care provided by general internists and by medical subspecialists.(12,33,38-40,44) Accordingly, we cannot know if such differences were present, and we are not able to conclude if differences in referral use between specialities would result in similar outcomes.

Comparison of outcomes of care between HMO and fee-for-service systems in the U.S. were used to answer this question indirectly because, by design, HMO have limited the access to subspecialized care through the interposition of a primary care generalist gatekeeper in addition to other control mechanisms. A review of literature done by the Agency for Health Care Policy and Research (12) in the U.S. showed that, for the three types of outcomes (biological health, health behaviours, and patient satisfaction), HMO patients received more preventive care, their biological outcomes were similar, and their satisfaction was similar or lower than the ones found in fee-for-services patients. However, the studies cited were not meant to address the specific comparison between general and subspecialized internal medicine and most of them did not measure consultation rate directly. Internists as well as general practitioners may have acted as gatekeepers. In that context, and because of the many differences in systems discussed previously, the application of such findings from the American situation to the Canadian health-care system is at best extremely limited.

We are left to conclude that we cannot answer the specific question about the impact on outcome of differences in subsequent consultations rates. Very indirect evidence could suggest that it is either absent or small.

4.1.8.3-Potential impact of a decreased use of subsequent referrals on continuity of care

One major concern raised about subspeciality care is its potential fragmentation for a given patient. (3,4,49,84,85) According to Fletcher and Fletcher, (49,85) this concern would be especially justified in our context of an aging population, where people are more likely to have multiple chronic diseases. They expressed the opinion that physicians who manage these patients should consider their problems in concert rather than piece-meal. A similar opinion is expressed by Campion.(84) While commenting about the importance of continuity of care in the elderly population, he stated that, as cases are getting more complex, the need for a co-ordinating physician who can integrate all the dimensions of a patient's health should become greater. Decreasing the number of subsequent referrals should theoretically decrease the total number of physicians involved in the care of one patient, in turn improving the continuity of care and easing its co-ordination.

Continuity of care has been the subject of numerous studies over the years. It has been defined and measured in various ways. Initially, continuous care was defined as the proportion of care received from one single physician or from several physicians seen through group practice or referral.(86-88) In 1977, Bice and Boxerman proposed a quantitative measure of continuity which considered as continuous the care received from different providers as long as it was co-ordinated.(88) Authors now distinguish between continuity, which represents the proportion of care received directly from the principal physician, and co-ordination, which is the proportion of care that the principal physician has planned.(89-93) Fletcher et al (92) proposed that we use the word "integration" to describe the sum of co-ordinated and continuous care. Dietrich et al (91) suggested that this sum should be designated by the proportion of "managed" care.

Continuity of care has been associated with beneficial effects on multiple aspects of care and in various settings. It has been shown to improve physician to patient relationship through improved communication and identification of problems, (94) improved patient satisfaction, (90,95,96) and personal satisfaction. (87,95) It improves compliance to follow-up and to treatment (87) as well as access to health care. (19) It decreases health-care-resource use through a decreased use of tests, (93) a decrease in length of stay when hospitalized, (90,93) and a decrease in the number of emergency-room admissions in the elderly. (90) In almost all the studies, continuity of care has been considered as an attribute of primary care and has been studied in outpatient populations. The study by Lofgren et al (93) was the only one involving a hospitalized population (n =146). They found, through their randomized trial, that the patients with the maximized continuity had fewer laboratory tests (32 vs 44, p = 0.01), a trend to decreased length of stay (6 vs 8 days, p = 0.06), while having similar in-hospital mortality (4% vs 3%) and discharge to nursing homes (29% vs 31%). In elderly patients, Col et al (97) found that the risk of being hospitalized because of non-compliance to treatment was increased proportionally to the number of physicians seen by a patient. In a study done in Quebec, Tamblyn et al (98) found that the most important risk factor associated with the prescription of a potentially inappropriate drug combination was the number of prescribing physicians.

Continuity of care is probably an important factor in the global quality of care. A decrease in subsequent referrals could improve continuity of care because of the smaller number of physicians involved, in turn improving some aspects of quality of care, if the global appropriateness of these referrals is maintained.

4.1.8.4-Potential impact of a decreased use of subsequent referrals on cost

The proportional variations of cost with referral rates is almost undebated. Most health care costs are generated through physicians for services or products provided to their patients directly or on prescription, or through referral for diagnostic or therapeutic procedures. Studies done in the United States suggest that for each dollar of cost generated by a family physician $2 are generated by the consultant physician, and $4 by the associated hospital.(99-101) In a population of 156 hospitalized patients who were seen in consultation, Lee et al (78) found that consultants recommended on average $300 worth of supplementary investigation (median of $113 per patient). Schneeweiss et al (99) studied the economic impact of a family medicine clinic in an academic medical center. They found that, for patients referred to medical subspecialities outpatient clinics, the charges per visit were of $127 on average, and increased to $321 per patient after a year (including laboratory tests). Another study done in an academic medical center with patients paying fee-for-services showed that the average referral generated $2,944 in combined hospital and professional charges over the following six months. The average cost was $6,792 for patients being hospitalized and $224 for patients managed only in an outpatient clinic. Hospital charges, consultant physician charges, and other physicians charges respectively accounted for 72%, 18%, and 10% of total charges. In this sample, 67% of the patients referred to internal medicine specialities were hospitalized in the following six months. (100)

Unfortunately, the cost of not referring a patient has not been measured as accurately. One can suppose that the patients referred in the previous studies would have needed care even if no consultant had been involved, and that some of these expenses would have been made anyway. Delayed referral may also result in adverse outcomes and necessitate more expensive interventions.

Even with these limitations, we can probably conclude that consultation and referral decisions made by physicians have an impact on the cost of health care. A decrease in subsequent referrals should probably decrease costs, unless a large proportion of patients who were not referred went on to develop potentially avoidable deterioration of their health status. This conclusion is based, however, on incomplete evidence, and no Canadian-based study was found to document the generalizability of these findings to our system of care.

4.2- A decreased use of diagnostic tests and technical resources

(see table 3 for a summary of the evidence presented)

The second assumption about the potential impact of general internal medicine care, when compared to subspecialized care, was that it could decrease the use of diagnostic tests and other technical ressources. Practices of general internists and of medical subspecialists have been studied as how they differ in the use of diagnostic tests and other technical resources for patients they see in consultation. Supporting and contradictory evidence will be presented regarding this assumption, and its impact on outcomes of care and cost will be analyzed.

4.2.1-Supporting evidence to the decreased use of diagnostic tests and technical resources by general internists

As underlined by Petersdorf (4), the American health-care system, which relies on a very high percentage of subspecialists, is much more costly than health-care systems in other western countries (such as Canada and the United Kingdom) where subspecialized care has a smaller role. This statement led many to conclude that overuse of expensive technology by specialists could partly explain these differences.

In the early 1980s, Manu et al (34) demonstrated that internists ordered 29% fewer tests ($p<0.01$) such as gastrointestinal procedures, bone marrow aspiration and exercise stress tests, for comparable patients. These patients were hospitalized arbitrarily to various specialities on a university hospital general medicine ward (n = 9 608 patients). Mendelhall et al (35) (n= 10 372 physicians) showed that for patients with three predetermined conditions (hypertension, coronary artery disease, and diabetes), subspecialists did more tests per patient than internists (30%, 47%, and 7% more respectively, $p<0.01$). However, internists were using 11% more tests than subspecialists for patients with chronic obstructive pulmonary diseases. The interpretation of their findings was difficult because statistically significant differences in baseline clinical characteristics were present in all conditions. Greenwald et al (36) in a survey of 3 000 U.S. physicians in an outpatient setting, found that cardiologists used more ECGs, but prescribed less drugs than internists for patients with coronary artery disease or hypertension. The number of other tests and chest X-rays was similar for the two specialities.

The major question that was left unanswered with these early findings is the impact of differences in resource use on health outcomes. The Medical Outcome Study attempted to address these issues. It started in 1986 and included 20 000 patients from various structures of care in the U.S. It showed that patients seen by cardiologists and endocrinologists were hospitalized more often and received more tests than patients seen by internists. Cardiologists also used more prescriptions than internists. These findings were still true, although attenuated, after various adjustments were made for differences of case-mix, severity and self-perception of health (odds ratio from 1.2 to 1.9 for the various comparisons, $p<0.05$).(37) A follow-up of this study published in 1995 by Greenfield et al (38) showed that for two targeted chronic conditions (hypertension and non-insulin dependent diabetes mellitus), an important difference in health-care resource use between subspecialists and internists persisted throughout the four years of active follow-up (point estimates were not provided). The various outcome measurements were similar between internists and subspecialists: the clinical condition measured after two years was similar (blood pressure control, glycated hemoglobin, presence of complications, etc...), as well as the self-perceived functional status and well-being measured after four years . The only exception was a better success with foot ulcers in diabetics treated by endocrinologists. The mortality rate was available at seven years and was also similar in both groups after adjustment. The high rates of losses to follow-up and the relatively low statistical power to detect differences for some outcomes due to their relative rarity were a concern with this paper. However, losses to follow-up were non differential between groups, and magnitude of differences between groups was not large enough to raise concerns about insufficient power.

Schreiber et al (44), who studied patients (n = 890) discharged with a diagnosis of unstable angina, also found that cardiologists used more invasive and non-invasive procedures than internists. Cardiologists also prescribed more drugs than internists in four major classes of anti-ischemic medications. However, major methodological problems were found with this study. The most important problem was the failure to adjust for very important differences between the groups at baseline. For example, general internal medicine patients had more atypical symptoms at presentation (52% vs 25%), and less previous history of cardiac disease (53% vs 81%). The direction of bias is difficult to estimate. It is expected that patients with atypical symptoms will require more tests to establish a diagnosis, in which case the decrease in use of tests for internal medicine patients would have been underestimated. However, it could be expected that patients with past medical history of coronary artery disease are more likely to obtain a cardiac catheterism when they present for another episode of unstable angina, in which case the decrease in use of tests for general internal medicine patients would have been overestimated.

The only Canadian-based research was a prospective study done by Lauzon et al (33) which compared patients consulting for acute myocardial infarction in one community-based hospital in Thetford Mines (Quebec), where they were treated by internists (n = 278), with patients consulting in eight tertiary care centers in Canada where they were treated by cardiologists (n = 2900). Considering only patients presenting their first myocardial infarction, and after adjustment for differences in baseline characteristics of severity, they found that patients treated by cardiologists had a much higher incidence of cardiac catheterization and angioplasty. No significant difference in by-pass surgery were found after one year. No significant differences were found for recurrence of myocardial infarction, angina, and mortality, both in hospital and after one year.(see table 2)

Table 2: Results of the study by Lauzon et al (33)
(% of patients at 1 year)

	catheterism	angioplasty	By-pass	mortality
Thetford Mines	34.4	7.8	10.7	13.1
Others centers	65.5	26.7	14.0	13.4
P value	<0.0001	<0.0001	NS	NS

Recently, Jollis et al (131) used a historical cohort design to study the impact of physician specialities on the outcome of patients with acute myocardial infarction (n = 8 421 Medicare patients from the U.S.). They demonstrated that internists used less tests than cardiologists (30% vs 49% angiographies and 13% vs 19% nuclear imagings for example). Internists used drug therapy less often (9.2% vs 15.8% of thrombolytics for example), and less by-pass surgery was performed on their patients (4.6% vs 10.3%) when compared to cardiologists. Adjusted mortality at 1 year was 12% lower for patients treated by cardiologists than for patients treated by general internists ($p<0.001$). These findings on outcomes are in contradiction with the prospective multicentered study by Lauzon et al (33), which found an important difference in the use of cardiac catheterization and angioplasty post-myocardial infarction, with similar outcomes of care in hospital and at one year after the event. Differences in sampling strategies in the two study may partly explain their divergent results. Another plausible explanation for the contradictory findings resides in the differences between general internists in Canada and in the United States, as to their type of practice (second vs first line), their training (4 vs 3 years), and accordingly their expertise in the management of a condition such as acute myocardial infarction. Because of this, we could be compelled to put more weight on the Canadian-based study.

4.2.2-Contradictory evidence to the decreased use of diagnostic tests and technical resources by general internists

Strauss et al (39) prospectively followed 213 patients with moderate or severe chronic obstructive lung disease for one year. After adjustment for severity, no difference was noted in costs, the number of days spent in a hospital or nursing home, the deterioration of pulmonary function tests or death, whether the patients were treated by general practitioners, internists or respirologists. Relevant to this study was the lack of power due to the small number of patients in each group (n = 46 in internal medicine group). Bernard et al (40) studied 2,609 patients, hospitalized on the general medicine ward of a teaching hospital, who were arbitrarily attributed to the care of different subspecialities. They showed that cost and length of stay were similar among patients who were under the care of internists and subspecialists. Finally, Levetan et al (41) showed that the presence of an endocrinologist consultant decreased the length of stay of diabetics hospitalized in general internal medicine from 8.2 to 5.5 days ($p<0.005$). One important problem with this study is the baseline differences between groups that were reported not to be statistically significant (n=104), but seemed quite important clinically (52% vs 30% respectively of insulin dependent diabetics in each group for example), and were not accounted for in the analysis. The authors of these three studies used length of stay as a proxy measurement of resource use. The limitation to this approach is that length of stay has been found not to be a good predictor for clinically relevant outcomes such as death, functional status, and patient satisfaction, and for subsequent use of resources (readmission).(42)

4.2.3-Summary of the evidence on the decreased use of diagnostic tests and technical resources by general internists

From the summary presented in table 3, we can see that 1- almost all available data shows either a decrease or a similar use of technical resources by internists when compared to subspecialists; 2- the data showing a decrease in use of tests by internists involved more patients with different types of diagnoses than data showing no difference; 3- the methodoligically strongest studies showed a decrease in use of test by internists (the study by Bernard (40) uses length of stay as its outcome, which may not be a good proxy for use of tests); 4- the only Canadian comparison showed a decrease in use of technical resources. One conclusion would be that overall it is likely that general internal medicine care decreases the use of health care technical resources when compared to subspecialized care.

Table 3: Summary of literature evidence on the potential decrease in use of diagnostic tests and other technical resources by general internists when compared to medical subspecialists

Author	Site	N	clinical conditions[a]	Conclusions[a*]
Lauzon (33)	Quebec	3,178 patients	AMI	⇓ cardiac catetherization and angioplasty. No difference in mortality, recurrence of AMI, or angina.
Manu (34)	NY state	9608 patients	Gen. medicine ward	⇓ technical tests. No outcome measured.
Mendenhall (35)	California	10,372 physicians	Htn, CAD, Db, COPD	⇓ tests for Htn, CAD and Db patients. ⇑ tests for COPD patients. No outcome measured. No adjustment for covariates.
Greenwald (36)	California	3,000 physicians	Htn, CAD	⇓ ECG.⇑ utilisation of prescribed drugs. No difference in other tests. No outcome measured.
Greenfield (37)	USA	20,000 patients	Db, Htn,CAD, CHF	⇓ tests.⇓ hospitalizations. No outcome measured.
Greenfield (38)	USA	532 patients	Db, Htn	⇓ tests. No difference in outcomes.
Jollis (131)	USA	8,241 patients	AMI	⇓ tests. 12% increase in mortality.
Schreiber (44)	Michigan	890 patients	Unstable angina	⇓ tests. No difference in outcomes. Important differences in baseline characteristics. No adjustment in the analysis.
Strauss (39)	Wash. state	213 patients	COPD	No difference in number of days in hospital, cost, or outcome. Low power.
Bernard (40)	Michigan	2,609 patients	Gen. medicine ward	No difference in length of stay and cost.
Levetan (41)	NY state	104 patients	Db	⇑ length of stay. ⇑ Hyperglycemia.

[a] AMI=acute myocardial infarction, Htn=hypertension, CAD=coronary artery disease, Db=diabetes, COPD=chronic obstructive pulmonary disease, CHF=chronic hearth failure.

*⇓ ,⇑ :Shows the results for general internal medicine patients, when compared with subspecialized care patients. For example "⇓ tests" mean that internal medicine patients have less tests than subspecialized care patients.

However, the majority of the evidence presented comes from primary care in the United States. It is possible that, for secondary care patients, who are likely to be sicker, this observation is different. The Canadian study and American studies done with hospitalized patients tend to show that this finding could still apply with a less healthy populations. All studies except for the ones performed by Greenfield et al (37,38), had a follow-up of one year or less. Consequently, we have very little evidence on the long term consequences of these differences in the use of tests by general internists and medical subspecialists.

Overall, even if most of the available data show a decrease in use of technical resources by internists, the evidence is certainly not as strong as it is believed generally, due to variations in methods, outcomes, and populations.

4.2.4-Potential consequences of a decreased use of diagnostic tests and technical resources

4.2.4.1-On outcomes of care

Of all the studies presented above, only four had both health outcome measurement and case-mix adjustment or randomization (the ones by Lauzon, Jollis, Greenfield, and Bernard). Three of them showed no difference in outcomes between general and subspecialized internal medicine patients, and one showed a 12% increase in mortality one year post AMI. From what has been presented, no definitive conclusion can be made on the impact of general versus subspecialized internal medicine care on outcomes. A weak trend for similar outcomes achieved with lesser use of technology can be hypothesized. However, some evidence is contradictory and the power to detect differences in outcome, if they exist, is very low. Most of the data comes from the United States and may not apply to our context of specialized-care delivery. Much more research is needed before we can answer this question satisfactorily.

4.2.4.2-On cost

One undebated issue is that a reduction in use of technical resources, if done appropriately, should result in a decrease in cost. Analysis of the sources of the growth in physician expenditures showed that, between 1985 and 1988 in the U.S., specialities with high technical content such as cardiology and gastroenterology experienced a more important increase in their expenses than general internal medicine (21.3%, 21.7% and 8.6% respectively).(48) General internal medicine care, based on previous findings, may reduce expenditures related to the use of expensive technical resources. In the United States, general internists are increasingly used as first line gatekeepers (in managed care organizations), to decrease use of subspecialized care. In Canada, general internists may be used as an intermediary step between primary care and subspecialized care. The benefit of general internal medicine care, in relationship to a reduction in expenditures, may be much smaller in Canada than in the United States. Internists seeing patients referred from general practitioners will need to refer some of them to subspecialized care because they may not have the technical expertise for required investigations, or because they lack of subspecialized training to manage them. For these patients, adding this step would not represent a true economy but rather a duplication of services. For general internists to have an appreciable impact on costs in Canada, they would have to decrease the use of subsequent consultations to subspecialized care as well as the use of technical resources.

4.3- Improved geographical access to specialized care in medium and small communities

The third assumption about the potential impact of general internal medicine care, when compared to subspecialized care, was that it could improve geographical access to specialized care in medium and small communities. The Quebec provincial government, as well as other organizations responsible for physician manpower planning, have targeted general specialities (such as general internal medicine or general surgery) to provide specialized care in small- and medium-size communities outside university centers in Quebec.(29-31) The goal of these measures was to prioritize the training of general internists in order to improve local access to specialized medical care in smaller and remote communities. The geographical distribution of subspecialists is limited by the necessity of a large enough population to sustain a viable group practice, and by the concentration of tertiary technologies inside academic tertiary-care centers.(15,18) For these reasons, very little debate remains concerning the policy decisions to increase the number of secondary care specialists in non-urban areas. Teams of internists provide specialized medical care in many of these areas in Quebec. In 1996, 32.5% of all general internists in the province were practising outside academic urban areas.(7,17,118) Because this impact is independant from our research question, we will not proceed further in the analysis of this assumption.

C) Conclusion

Provincial governments in Canada, and particularly the Quebec government, with the co-operation of medical faculties and other medical authorities are presently adapting physician training to increase the number of general internists, and the structure of care to institute a second line of medical intervention between general practitioners and subspecialists. While increasing the number of general internists will provide greater access to specialized care in rural and remote areas, it is also assumed that increasing the use of general internists will lower costs related to the use of subspeciality care, without compromising outcomes. Most of the evidence supporting these assumptions is weak, and may not be generalizable directly to the Canadian context. Even if the assumption of a decrease in the use of technical resources is likely to apply here, we are not certain of its impact on outcomes of care. The assumption about a decrease in subsequent use of physician resources is not documented by any study. This last assumption is crucial because, without this effect, no gain in continuity of care should be expected which would limit any potential gain in quality of care. Cost savings through lesser technology-use could be more than offset by an increase in physician-resource use.

The debate about the role of general internists and their training requirements, when compared to medical subspecialists, is presently ongoing at the political level, with seemingly little empirical information, and with potentially important impacts on the delivery of health care in Quebec and Canada.

RESEARCH QUESTION

Principal research objective

The primary objective of this study is to determine if there are differences in the number of subsequent consultations to specialists, between patients seen initially in consultation by general internists and by medical subspecialists.

Secondary research objectives

1- To determine if there are differences in the continuity of the care received by patients seen initially in consultation by general internists and by medical subspecialists.

2- To determine if there are differences in the professional charges generated for patients seen initially in consultation by general internists and by medical subspecialists.

Hypotheses

1- Patients referred initially to general internists will have a smaller number of subsequent referrals for consultation to other specialists than comparable patients referred initially to medical subspecialists.

2- Continuity of care will improve with a smaller number of subsequent referrals and will be higher for general internists' patients.

3- Professional charges will increase with a higher number of subsequent referrals and will be lower for general internists' patients.

METHODOLOGY

1- Study design

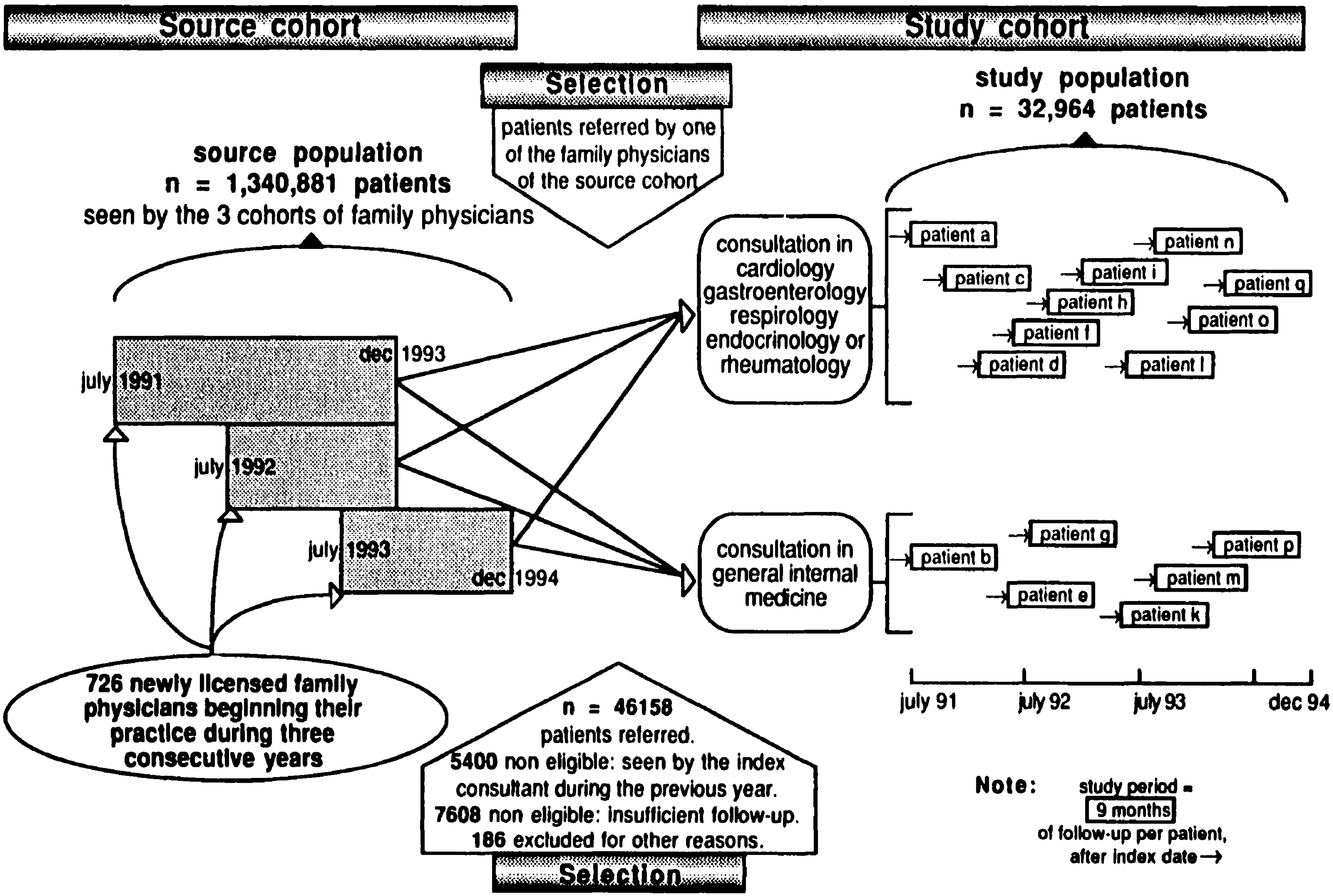
A historical cohort design was used to answer the research question. This approach was selected because of the relatively high frequency of referrals in the population, and because an unbiased measure of referrals for consultation could be directly obtained through this design.

The cohort of the present study was nested inside a larger cohort that has been studied in another protocol.(69) We will use the terms "source cohort" or "source population" to describe this larger cohort of patients from which we sampled for the present study. The population of the present study will be called the "study population" or "study cohort". We will first describe the source cohort. We will then explain the sampling process of the study cohort among the source cohort population. This two-step selection process is schematized in figure 1.

1.1- Population of the source cohort

The cohort of all the family physicians who passed their family medicine licensure examination and applied for Quebec licensure in 1991, 1992 or 1993 has been assembled by Tamblyn et al (69) to study the association between examination scores and practice patterns of family physicians. Information has been gathered on every patient seen by these physicians during the first 18 to 30 months of their practice. For all these patients, additional information on an 18-month period preceding the physician's entry into practice has been assembled to provide "baseline status" data. The eligible patient population was composed of all patients who made a fee-for-service visit to one of the physicians of the cohort and who were residing in Quebec for the calendar year of their visit. Patients who received a prescription from these physicians, or who were referred by them were also included. A total of 743 family physicians were eligible for inclusion among which 726 started their practice in the 18 months following their licensure examination. They saw a total of 1 340 881 individuals, who represent 19% of the total population of the province. Over seventy million claims for medical services and prescriptions were retrieved for these patients.

Figure 1: Description of the study population and selection process



1.2- Population of the present study

The present study included all the patients who were 21 years of age or older, referred by a family physician of the source cohort, for a consultation with an eligible medical specialist. The specific specialities who were included in the study were general internal medicine, cardiology, respirology, gastroenterology, rheumatology and endocrinology. These specialities have been chosen because their training overlaps substantially with general internal medicine. They all share three years of general internal medicine core before specific subspeciality training. Exceptions were made for nephrology and hematology which were not included in the study. Even though they share three years of core training with the other specialities, chronically dialysed patients and patients receiving cycles of chemotherapy, which may represent an important part of their respective practices, frequently obtain primary care services directly from their specialists because of the frequency of their appointments. These patient populations are probably not comparable to other specialities' populations for pattern of health-care resource use and we excluded these two specialities. Neurology patients were not eligible even if this patient population may represent a substantial part of general internists' case-mix. As neurology training only shares one year of common training with general internal medicine, the respective expertise of neurologists and general internists may become very difficult to compare even for the same types of clinical problems. The data on speciality status of the consultant were retrieved from physician claims database (see section 2.3 below).

The point of entry in the present study was set for each patient at the date of his / her consultation (thereafter named "index date") with one of the eligible specialists (thereafter designated as the "index consultant"). The patients were entered in the general internal medicine cohort of patients (thereafter designated as the GIM cohort) if the index consultant was an internist, or in the subspeciality cohort of patients (thereafter named subspeciality cohort) if the index consultant was one of the other five types of specialists cited above[2] .

[2]We will use the terms "GIM patients" to identify the patients of the GIM cohort and "Subspeciality patients" to identify patients of the subspeciality cohort.

Outcome information for each patient was retrieved for a period of nine months after his / her index date (the study period). Only the first consultation to an eligible specialist was considered for patient allocation. Patients were not allowed to be entered in another study group even if they were referred again by a family physician of the source cohort to an eligible specialist during the study period. To maintain independent units of analysis, patients were not allowed to be re-entered in the study for a second time after the nine months of follow-up of a previous entry. Information on confounding variables was retrieved for each patient from a "baseline" period of 18 months preceding his / her index date. The proportion of subjects recruited in each subspeciality and the case-mix inside each speciality's patient population was the direct consequence of the family physicians' practice in the source cohort .

Patients referred to eligible specialists exclusively for technical diagnostic or therapeutic procedures were not included. Our purpose was not to compare the technical intervention or the expertise given on specific tests by specialists, but rather to compare how global management of patients by consultants could affect the subsequent use of health care resources. In order to ensure that patients included represented new cases evaluated by a given specialist, we excluded patients who were seen by the index consultant for any type of visit, in the 12 months preceding their index consultation.

Patients seen in consultation less than three months before the end of the available follow-up period were excluded. The median patient waiting time to see a general internist in hospital outpatient clinics after referral from a general practitioner in Quebec was two weeks in 1994 and this delay was highly variable between specialities, ranging from one to eight weeks.(106) Accordingly, we judged that a minimum of three months of observation was necessary to allow subsequent referral activity to be measured, especially if more than one referral was involved.

Consultation claims involving patients' temporary identification numbers or incomplete information on one of the study variables were excluded.

Consultations were categorized depending on the setting of their occurrence. Four different settings were considered: 1-outpatient, 2-emergency room, 3-acute care hospitals with the exception of intensive or coronary care units (ICU or CCU), and 4-ICU/CCU. Consultation claims occurring in long-term care facilities were excluded.

2- Description of the data sources

Five databases were linked to retreive the information needed to conduct this study. Three of these were administered by Quebec's universal health insurance plan (Régie de l'Assurance-Maladie du Québec or RAMQ). They were linked by unique patient and physician identifiers that were encrypted prior to the release of the information to protect confidentiality. The Statistics Canada 1992 census data and the Quebec Ministry of Transport's database were also used, and linked by health district.

2.1-Medicare registrant database: Contains the Medicare number, name, address, region, sex, year of birth, day of death and preferred language of all Quebec residents who applied for provincial health insurance coverage (approximately 97.7% of all Quebecers).(103) To protect the anonymity of patients, only the first three digits of the postal codes were provided.

2.2-Practicing physician database: Contains the license number issued to the physicians as well as their medical school, year of graduation, speciality, year of birth, and gender. These data are provided by the Quebec College of Physicians which requires this information from each physician applying for a license in the province.

2.3-Physician claims database: Contains information on medical services provided on a fee-for-services basis. Each physician claim record includes the patient Medicare number, the physician license number, the physician's speciality, the date of delivery of the service, the code of the medical service provided, the diagnosis for the visit (ICD 9 classification), the location of the service (critical care or emergency room for example), the license number of the physician who referred the patient and the amount paid for the service. With the exception of patient diagnosis, all information must be present and meet internal validation checks for the physician to be reimbursed for the service. A validation study of the accuracy of billing data for 234 office visits made to 51 general practitioners demonstrated that no claim was made for 2.6% of visits, data was accurate in 97.8% of visits, and codes for the service delivered were accurate in 100% of visits.(104)

2.4-Statistics Canada census data: Contains information about the income and education level of Quebec residents. It was used to create ecological measures of the socio-demographic characteristics of the patient population. To protect confidentiality, this information was provided in grouped form, for the 170 CLSC[3] districts in Quebec. The CLSC district from the medicare registrant database was used to link each patient with summary census data, and to assign them an ecological measure of income and education level. Postal code information has been considered to obtain socio-demographic data. We used CLSC district information because it provides a more refined classification than the first three digits of the postal code in rural areas.

2.5-Geographic distance file: The Quebec Ministry of Transport provided the investigators with the distance, by road, from the central point in the CLSC district to the central point of the nearest metropolitan academic tertiary care center: Montreal, Quebec City or Sherbrooke. The CLSC designation for each patient in the study population was used to link the geographic distance file to patient information.(105)

3- Outcome definition and measurement

3.1- Principal outcome: Number of subsequent medical consultations:

The principal outcome variable was the number of subsequent medical consultations per patient, in the nine months following the index date.

[3] The CLSCs or "Centre Local de Services Communautaires" are a public network of first line health and social services organizations that cover all the province of Quebec.

Medical consultations[4] were defined as consultations to any speciality for which training is required in internal medicine programs in Quebec. They are general internal medicine, cardiology, respirology, gastroenterology, endocrinology, rheumatology, dermatology, hematology, medical microbiology, neurology, nephrology and geriatrics.

Subsequent consultations requested by any physician (rather than only those requested by index consultants) were included in the outcome. This choice was justified by the multiple potential mechanisms involved in the generation of subsequent consultations (see literature review, section 4.1.6.2). For example, a specialist seeing a patient can decide to request another consultant himself, or give the advice to the referring practitioner to refer the patient to another consultant. A patient or a referring physician can also consult another specialist if the results of the first consultation were not satisfactory, if the problem has evolved, or if other problems were noticed. A broad definition of the outcome, including subsequent consultations asked by any physician, should allow the measurement of the real impact of the index consultation at the patient level. It should also decrease potential biases created by the unequal probabilities, between general internists and medical subspecialists, of directly asking subsequent referrals due to systematic differences in their approach to care, as explained in the literature review (section 4.1.6.3).

Outcome information was gathered for three periods of three months (0 to 3 months, 3 to 6 months, and 6 to 9 months) after the index visit. Patients' follow-up information had to be available for an entire three-month period to be included in the eligible population of any specific period. Patients dying during a follow-up period were excluded from the eligible population of the following period(s). Subdivided time-windows were used because we expected to find a "cascade phenomenon" in the subsequent consultation requests following the index visit.(46-47) It was anticipated that the effect of the consultant's speciality on subsequent referrals would be more important early after the consultation,

[4] For the purpose of the actual presentation, consultations to these specialities will be labeled as "medical" consultations. They represent a subgroup of all the consultations to any specialities (including also surgical specialities or psychiatry as examples) which will be designated as "total" consultations.

and would disappear progressively with time, the last period (between 6 and 9 months) being principally the result of the impact of other determinants of health care use. Smaller time-windows would have allowed more precise assessment of this cascade effect, but the small number of expected consultations in each window would have produced unstable estimates. Although no literature was found to support the choice of the total length of follow-up, we postulated that it was unlikely that a single consultation would have measurable effect after more than six to nine months. One exception would be in the cases where the index consultant continued to follow a patient after the initial consultation, which should happen only for a minority of the new patients in specialists' practices.

3.2- Secondary outcomes:

3.2.1-Medical versus total subsequent consultations

The total number of subsequent referrals for consultation to any speciality was also calculated. Because subspecialists are expected to restrict their evaluation of patients to their field of expertise, they could be less likely to detect problems that would require consultations outside the internal medicine field (e.g. surgical). If this phenomenon existed in reality, a decrease in subsequent referral rates to "medical" specialities for general internal medicine patients could then be accompanied by an increase in subsequent referrals to other specialities that could partially or totally offset the first effect on the total number of subsequent referrals. We compared the number of subsequent "medical" consultations with the total number of subsequent consultations in order to explore this possibility.

3.2.2-Continuity of care

We postulated that a decrease in use of subsequent referrals should improve continuity of care for a given patient, whoever his/her regular physician was. The usual provider continuity (UPC), which is defined as the proportion of visits made to the usual provider, is the simplest and one of the most widely used measure of continuity of care.(89-93) As explained by Black (130), this measure has the disadvantage of being more correlated with use levels than other measures of continuity. However, it is an easily interpretable and understandable measure of concentration of care. This last characteristic was of particular importance in our study because we did not restrict our population to outpatients receiving primary care, for which continuity of care measures have been generally developed and validated. In this context, a measure with no intrinsic numerical significance such as Bice and Boxerman index (88) would be more difficult to interpret for the inpatient portion of our population, even if this measure is more sophisticated and less correlated with the level of use of services. Consequently, we preferred the usual provider continuity because we intended to use our continuity index partially outside the precise context for which it has been validated.

For each patient, we determined who was the physician he/she saw more often than any other in the three months following index date, and noted his/her speciality. We calculated the proportion of all visits that were made to this most prevalent physician. We included any type of visit (consultation, follow-up visit, etc...), but excluded claims for radiology and nuclear medicine procedures, as well as test interpretations such as spirometry or electroencephalography. This index was calculated for each patient who had two or more visits in the follow-up period, including the index visit.

The total number of different physicians a patient has seen has been associated with an increased risk of hospitalization due to non-compliance to treatment (97) and with an increased risk of potentially inappropriate drug combinations in the elderly.(98) The total number of different physicians seen by a patient in the first three months after the index consultation was used as a second continuity measure, and compared with UPC. We applied the same restrictions to the construction of this variable which were used in the computation of UPC.

3.2.3-Professional charges

We used the information on the amount paid to physicians on their billing records to compute two measures of professional service charges for the three months following the index consultation. Charges for claims made directly or on the request of the index consultants were added, to compute an "index consultant's charges" variable. We also calculated the total charges billed by any physician for each patient. This measure has been designated as the "total charges" variable. Because of the nature of the data sources, the amounts calculated did not include hospitalization costs or technical procedures costs other than physician's professional charges associated with them.

4- Confounding variables

Many different variables have been found to be associated with the use of referrals. These determinants were grouped in the following categories: 1-patient characteristics, 2-referring physician characteristics, 3- health-care system characteristics, 4-consulting physician characteristics, and 5-personal interaction characteristics (see literature review, section 4.1.4). A description of measurements used in each of these categories follows.

4.1- Patient characteristics

Characteristics of patients play an important role in the use of referral and must be assessed in comparison between medical practices. They can be further subdivided into socio-demographic and medical characteristics (often described as the case-mix).

4.1.1-Socio-demographic variables

4.1.1.1-Gender and Age: They were extracted from the Medicare Registrant database. Gender was provided directly for each patient in the study. To protect confidentiality, age was provided in categories of year of birth. Eleven categories were used: born before 1920, 1920-24, 1925-29, 1930-34, 1935-39, 1940-44, 1945-49, 1950-54, 1955-59, 1960-64 and 1965-69. Subjects born after 1969 were excluded to ensure that only adult subjects were included. We decided to exclude children to preserve comparability between groups because general internists do not see children in consultation (since this is the role of general pediatricians), while medical subspecialists do.

Two concerns are associated with this type of categorization. Firstly, some degree of overlap will be present because subjects may have entered the study during four different years. For example, persons born in 1925 to 1929 could have been between 62 and 66 years old at the index date if it was in 1991, but could also have been up to 69 years old if they entered the study population in 1994, thus overlapping with the age distribution of the 1920 to 1924 category. To address this question, we transformed the year of birth categorization into a continuous age variable. An age was attributed to every patient corresponding to the median value of the age distribution inside his/her date of birth category, after accounting for the year of entry into the study. These category-specific age distributions were based on the Statistics Canada 1991 census data. For example, the 1955 to 1959 year of birth category subjects were assigned the age of 34 if they entered the study population in 1991, 35 in 1992, 36 in 1993, and 37 in 1994. Sex specific age distributions were used for the oldest category. The age transformation of this category (born before 1920) is summarized in table 4.

Table 4: Age attribution in the oldest age category (born before 1920)

index year	age distribution	median age men	median age women
1991	≥ 71	76	77
1992	≥ 72	77	78
1993	≥ 73	78	79
1994	≥ 74	78	79

Secondly, the width of the oldest category increased the possibility of residual confounding by age. This could have had some importance if health-care resource use systematically varied between 72 and 80+ years old, and if the age distribution inside this category was different between study groups. We did not have access to these intracategory distributions and we could not evaluate precisely if it resulted in confounding, and in what direction it could have gone. However, if residual confounding by age was present, its magnitude should have been limited overall by the relatively small width of the other categories. Also, age being a proxy for health status, information on comorbidity, severity of disease, and pattern of health-care system use should have decreased this residual confounding phenomenon inside the elderly category.

4.1.1.2-Socio-economic status: Income and education level are two measures commonly used to summarize a patient's socio-economic status. Socio-economic status has been associated with health status and use of health-care resources. Its importance and the direction of its impact as a determinant of specialized care use is not clear as conflicting results were obtained.(56,62) In a study done in Manitoba, Roos and Mustard (107) found ecological measures of SES to be correlated with health status, death, and hospitalization, but not with specialized consultation services. We decided to include these variables in the model, even though we anticipated that socio-economic status would have a small impact on the principal outcome.

An average measure of income and education was computed by Statistics Canada for each of the 170 CLSC districts of the province of Quebec. Each patient was attributed the measure computed for both variables according to his district of residence. The average family income was used to evaluate economic status. Using the approach outlined by Blishen (108), a summary index of educational status (net education level) was used to evaluate education level. The highest level of education achieved by residents of a CLSC district is summarized by Statistics Canada in six mutually exclusive categories. Net education level is the result of the substraction of the proportion of people without a high-school certificate from the proportion of people with a university degree or a post-secondary diploma. A positive result indicates a higher proportion of university-educated people and a negative result indicates a higher proportion of high school non-attendees or drop-outs. These two variables were treated as continuous measures in the analysis.

Demissie et al (109) evaluated the validity of ecological variables as an approximation of socio-economic status (SES) in a population of asthmatic children in Montreal. When compared to proxy measurement of SES collected individually, they found that only 30% and 34% of the subjects were attributed the proper quintile for net educational level and median income respectively; discrepancies were within one quintile in 34% of the cases for educational level and within 40% of the cases for median income. Despite these important errors, correlation coefficients between the clinical outcome of that study (pulmonary function tests) and SES values, were of similar magnitude for individual (r = 0.09) and ecological measures (r = 0.06 for net educational level, and r = 0.07 for median income). Another interesting finding of this study was that ecological measures derived from different sizes of ecological approximation gave remarkably similar results. The smallest groupings were enumeration areas which contained a maximum of 375 households, and the largest were census tracts which contained an average of 4 000 households. They did not compare these two types of groupings with the groupings used in the present study (CLSC districts), which were on average 10 times bigger than census tracts in urban areas, but smaller in rural areas. Therefore, we could not evaluate precisely the degree of misclassification potentially generated because of the size of our ecological approximation.

Socio-economic status constitutes another proxy for health status and access to care. It is possible that the random error of these indices was non negligible due to their ecological nature. It is also possible that systematic error in these indices underestimated income and educational level (e.g., patients who consult may be less healthy and may have, on average, a lower income than the mean population in any given CLSC district). However, it is likely that these measurement errors would have affected study groups non differentially. Some residual confounding may have resulted, that should have been partially corrected by the presence of other indirect measures of health status and access to care such as comorbidity and previous pattern of health services use.

<u>4.1.1.3-Geographical location of primary care / access to subsequent referrals:</u> Geographical location of primary care was evaluated ecologically by measuring distance, for each patient, from his/her CLSC district to the nearest academic tertiary care center (Montreal, Quebec City, and Sherbrooke), through the use of the Geographic Distance File. Each patient was assigned a kilometer value according to his/her CLSC district of residence. Patients living in far north locations were attributed a distance of 999 km. The setting of the primary care practice (urban vs rural) was reported as a referral determinant at the physician level.(53) In the present study, the site of residence of <u>patients</u> was used to evaluate both the setting of primary care and the geographical access to care.

Distance to the nearest tertiary care center should reflect the importance of the effort necessitated to access subsequent referrals, especially when academic tertiary care resources are needed. This variable was examined both as continuous and categorical in regression models (see regression model development section for details).

4.1.2-Patients' health status variables

4.1.2.1-Importance of the case-mix assessment

The patient mix of general internists' and subspecialists' practices, though overlapping substantially, can also be quite different. In the present study, the patient's health status, the type of disease, and the propensity to health care services use constituted important potential confounding variables. As demonstrated by Kravitz et al (54), major differences in the case-mix can be found between specialities. Many authors have outlined the importance of proper adjustment for comorbidity and severity of disease in patient populations to achieve valid comparisons between medical practices. This is true whether the studied outcome is hospital length of stay, (42,115) hospital admission or readmission, (37,42,112) future use of outpatient services, (37,113) cost, (114) mortality, (42,110-112) or other outcomes of care. (38,42)

Various methods to categorize patients into more homogeneous and comparable groups have been developed and validated in the literature. Our study population was recruited both from inpatient and outpatients care. Consequently, we decided to include two validated comorbidity indices; one that was developed with inpatients and another developed with outpatients. To improve our confounding variable adjustment, we took advantage of the considerable amount of information on health-care services use that was available for each patient in our database, and computed a variety of indicators related both to health status and propensity to use resources. In the next sections, we will describe the two indices used, and the health services variables that were created for this study.

4.1.2.2-Definition and measurement of health status variables

Charlson comorbidity index: This index was developed by Charlson et al in the United States to predict mortality at one year for consecutive patients hospitalized on a medical ward, depending on the presence of a variety of medical conditions, as recorded through hospital chart review. It has been initially validated in a different population having a single disease (breast cancer), and it was found to be a good predictor of death secondary to comorbid conditions in the ten years following the initial diagnosis. The index consists of the weighted sum of 19 significant comorbid conditions. The weights are based on the relative risk of mortality when the condition is present versus absent.(116)

Other authors have validated this comorbidity index with different sources of data, different populations, and various outcomes. Roos et al (112) found that the Charlson index was a good predictor of mortality at one year and readmission at three months in patients receiving common surgical procedures (prostatectomy, cholecystectomy, and coronary artery by-pass graft surgery (CABG)). This study was done in Manitoba with 1 584 subjects. Comorbidity information was collected through physician claims and hospital discharge data from the surgery hospitalization and for the preceding six months. A clinical severity score (American Society of Anesthesiologists' (ASA) Physical Status score) calculated through chart review did not improve the model after the addition of Charlson's index. Correlation coefficients between Charlson score and outcomes measured were better for mortality (0.46 to 0.72) than for readmission (0.23 to 0.38). Using chart review, Krousel-Wood et al (117) compared the Charlson index with other comorbidity indices in 302 patients undergoing prostatectomy. They found different levels of sensitivity for the compared indices, but all were significantly associated with five-year mortality and produced a similar effect on the principal measure of association under study. Matsui et al (118) found the Charlson index to be correlated with length of stay in a population of 1 261 patients hospitalized with acute chest pain, after adjustment for other clinical variables prospectively collected, including many markers of severity of the heart condition.

Deyo et al (119) adapted this index for use with administrative databases using ICD-9 CM diagnostic codes. They validated their adapted index on a population of 27 111 patients undergoing lumbar-spine surgery, using Medicare claims for the year preceding the surgery as the source of comorbidity data. In this relatively healthy population (71% had a score of 0), they found the index to be a predictor of mortality, postoperative complications, use of blood transfusion, discharge to nursing homes, length of stay and hospital charges. These associations remained true when using only the codes available from the admission for the surgery, even if the scores were lower on average and fewer medical conditions were detected than with the inclusion of information from the preceding year. Some controversy took place on the precise list of diagnostic codes to use as the translation of the 19 clinical conditions initially included in the index.(120-122) Romano et al (123) did a comparison of two different lists of codes on two populations with different outcomes. Substantial variations were present in the coding, but results were similar for both lists in predicting mortality at one year after CABG and in-hospital complications after lumbar discectomy.

Concerns may be raised about the reliability of our administrative database, despite the validation studies cited above. Jollis et al (125) evaluated the agreement between various data sources. They found that administrative data from the United States (which included information from discharge summaries), collected at only one hospitalization for each patient, had unpredictable sensitivity (from 14% for unstable angina to 83% for diabetes mellitus), but high specificity (from 91% to 98%), when compared with prospectively collected clinical data. However, the authors recorded data cross-sectionally and the impact of these discrepancies on the prognostic power of each datasource was not measured. As mentioned previously, the addition of clinically based prognostic scores to the Charlson index collected over a six-month period was not found to add predictive information on mortality, and readmission in another study.(112) Malenka et al (126) compared chart- and claim-based data from Manitoba for 485 patients undergoing a prostatectomy and computed their Charlson comorbidity score. They used only the claim data of the surgical hospitalization and did not include prior information. The claimed-based data had less sensitivity than the chart-based comorbidity index in the prediction of mortality, although both gave significant results. The combination of the two datasources produced the index with the highest predictive value. None of the two studies cited above used longitudinal information to increase sensitivity. Prior studies suggested that increasing the period of data collection should increase the sensitivity of this approach.(119) A validity analysis of the Charlson index has been performed on a subset of 10 000 randomly chosen elderly patients of our source population. The results showed that the co-morbidity index value was the second strongest predictor of survival after age. Sex, visit frequency, acute care hospitalization, ICU admission and nursing home admission were the other variables studied.(124)

In the present study, the Charlson comorbidity index was computed for each patient using diagnostic codes (ICD9) listed in the physician-claims from index visit and all visits to any physician (either from family practitioners or specialists) that were billed in the 18 months prior to the index visit. We used the list of ICD9-CM codes proposed by Deyo et al (117) because it was validated with a higher number of patients from different settings.(see appendix 1) We adapted some of the ICD-9CM codes to the ICD-9 classification which was used on the billing files; a slight decrease in precision could result from the absence of the second decimal point in ICD-9.

The variety of settings and medical conditions for which this index has been validated led us to believe in its robustness and utility in our study, especially for the subgroup of patients hospitalized at the time of the index visit. Its ability to predict use of resources (length of stay for example) in some situations was also an advantage in the context of our research. Some misclassification was expected because of the administrative nature of the datasources. This missclassification is likely to be non-differential between study groups.

Ambulatory Diagnostic Groups (ADG) and Ambulatory Care Groups (ACG): These groupings have been developed as a measure of ambulatory care case-mix. They have been elaborated and validated using administrative databases with diagnostic codes. More than 7 000 of the most common ICD9-

CM codes are recognized by this system.(127) All diagnostic codes are first clustered into 34 categories (ADG) with relative homogeneity for expected health service resource consumption. The criteria guiding the clustering process are the following:

1-likelihood of persistence or recurrence of disease;
2-likelihood of return visit and/or the need for continued treatment;
3-likelihood of the need for specialist services;
4-likelihood of decreased life expectancy;
5-likelihood of short-term or long-term patient disability;
6- expected need and cost of diagnostic and therapeutic procedure;
7-likelihood of a required hospitalization.

A decisional algorithm is then aplied to attribute one of the 51 mutually exclusive Ambulatory Care Groups (ACG) to each patient. This algorithm takes in account the number of different ADG(s) attributed to a patient, the nature of these ADGs, and the age and gender of each patient (see appendix 2 for a description of the 34 ADG clusters).(128-130)

In the population used for their elaboration, ACG groupings retrospectively explained 50% of the variation in resources used. This technique has been validated prospectively into four HMO populations in the United States and has been shown to predict 20% of the variation of ambulatory resource use over one year.(128,129) The limitations previously raised for the Charlson index on the validity of the data sources may also apply to ACG, even if ACG were developed using the same type of data that we were using in the present study. All the diagnostic codes recorded for a patient in the 18 months prior to the index date were used in ADG computations. This is in agreement with the recommendations made that at least six months and preferably one year or more of longitudinal data be used in their computation.(127,130) We compared the predictive power of ADG groupings (after the initial clustering from ICD9 codes) and ACG groupings (the final, 51 level categorization using age and gender) and decided to use ADG groupings in our statistical model because they gave the highest predictive scores and because we already had information on age and gender in separate variables.

Previous pattern of services utilization variables: Administrative information on previous health care resource use by our patients was utilized to obtain indirect information on health status, severity of disease, and propensity to services use. All the following variables were assembled from an 18 month period preceding the index date for each patient, excluding the index visit. They were examined both as continuous and categorical measures in regression models.

Total number of visits to physicians: All visits to any physician were added. Only one visit per day per physician was counted even if more than one claim was made by the same physician during one day. Claims sent by two different physicians for the same patient on a given day, were counted as two visits.

Total number of visits to specialists: From the above total, visits charged by specialists were extracted.

Number of visits to emergency room: All visits made in an emergency room setting were retrieved. Each different day a patient received services in the emergency room was counted as one visit, and their total was calculated without consideration for the number of physicians seen during each visit.

Number of different physicians providing services: Was defined as the total number of different physicians who billed for each patient during his/her 18 months baseline period.

Number of acute hospitalizations: A patient was considered hospitalized when more than one consecutive claim from acute-care hospital setting was billed for his\her care. This information was available from the location code requested for physician claims. Subsequent hospitalizations were detected when patients had sequences of more than one consecutive acute-care hospital claims that were separated by claims from other settings of care (outpatient as an example), or by a one month period between consecutive inhospital claims.

Number of admissions to intensive care or coronary care units (ICU/CCU): Using billing codes from intensive and coronary care units, the number of admissions to ICU/CCU was obtained. More than one ICU admission could be detected during the same hospitalization if consecutive claims from ICU were separated by claims from regular ward setting.

4.1.2.3- Validity of health status variables

None of our health status variable taken alone could have provided us with an accurate picture of our population's disease burden. However, as a group, these measures explained a substantial proportion of the variance in primary care referral rates in our source population (48.1%).(124) They should provide a reasonable estimate of our patients' health status at entry into the present study. Acute hospitalization, ICU admission and specialized care visits in the 18 months prior to entry in the study should be powerful markers of disease severity and complexity. They also give us information on how particular patients interact with the health-care system and react to illness in terms of propensity to resource use. These variables and particularly other variables such as the number of different physicians, the total number of visits to physicians and the number of visits to the emergency room should be of particular interest in assessing these personal interaction characteristics. Finally, these markers also provide us with indirect information on access to health-care services.

4.2- Physician characteristics

4.2.1-Index consultant

In this study, the index consultant plays both the role of consultant and subsequent referring physician for his patients. Characteristics other than the type of speciality could have acted as confounders. Information on physician-associated referral determinants was obtained for each index consultant. Gender was directly available in our source dataset. Time since entry into practice was provided in five categories: graduated before 1960, between 1960 and 1969, between 1970 and 1979, between 1980 and 1988, and after 1988. The two other characteristics found to have importance through our literature review were as follows: 1-setting of practice, which is indirectly evaluated with the geographical distance variable, and 2- expertise levels, which we assumed to be comparable between groups, relatively to the broadness and depth of expected knowledge of each speciality.

4.2.2-Initial referring physician

As stated previously, the initial referring general practitioner could have had some impact on subsequent referrals, even if these physicians may not have been the regular source of primary care of our study patients. By definition in the present study, the referring physician for the index consultation had to be one of the newly licensed family physician of the source cohort. Variability in the characteristics of these physicians, such as professional experience and age, was limited by this design strategy.

4.2.3-Subsequent consulting physicians

Characteristics of physicians executing the subsequent referrals should not have affected the association under study because all specialist physicians in the province were potential consultants for both cohorts of our study population. Accordingly, they could be assimilated as one of the components of the system of care, which was the same for every patient. The only factor modulating characteristics of consulting physicians was access to services, geographical and organizational. Distance to tertiary care center was used to assess geographical access to care. Organizational access limitations not explained by the geographical characteristics (e.g., size of waiting lists or limitations in availability for new patients) were assumed to be randomly distributed between study groups. A systematic variation in organizational access between groups would be difficult to conceive given the variety of situations and the huge number of physicians and patients involved in the many outcome events in each group. If ever this assumption was not verified, previous pattern of services utilization variables (especially the number of visits to specialists) should account, at least partially, for differential organizational access to care due to variations of subsequent consultant practices.

4.3- Health-care system characteristics

System of care should not cause confounding since all patients were using the same universal system of care. This is one important strength of the present study which does not select patients according to their health insurance plan. However, the setting of the index visit could have influenced greatly the number and the timing of subsequent referrals. For this reason, patients were categorized according to the setting of the index consultation into four subgroups: outpatient, emergency room, acute care hospital (with the exception of ICU /CCU), and ICU / CCU. The setting was introduced as three binary variables in the regression model, using outpatient as the reference category.

4.4- Personal interaction characteristics

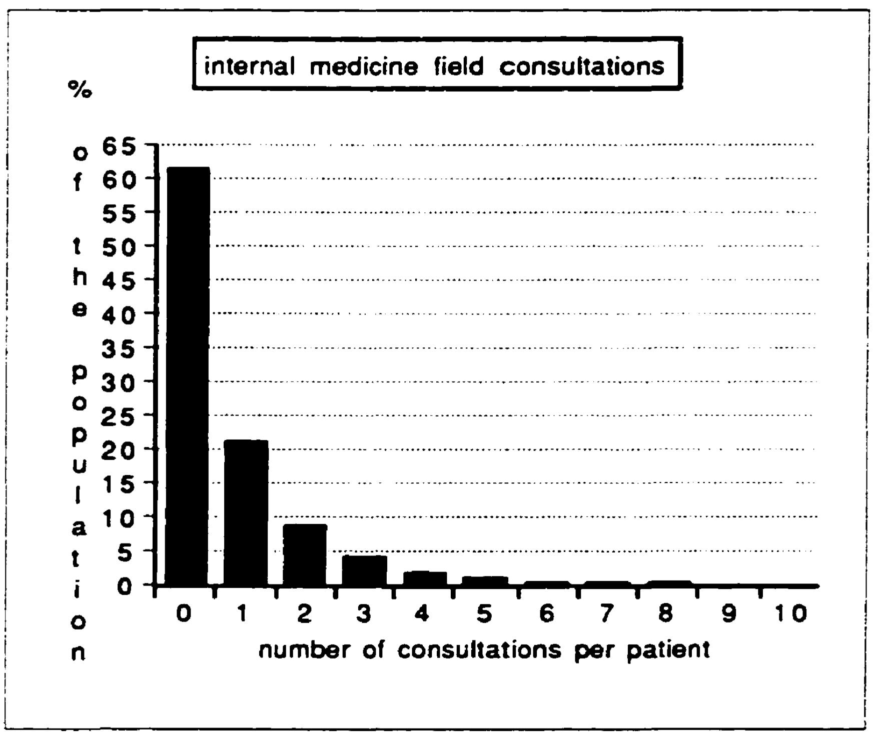
Considering the almost infinite number of components of personal interactions involved in this study, either patient-physician or referring-consultant physician, this group of referral determinants should have had a non-differential influence among study groups. As mentioned before, personal characteristics of patients that would influence their interactions with physicians should already be reflected at least partially by previous pattern of services utilization variables. In this context, if there were a systematic variation of these personal interaction characteristics between study groups, we could think of it as a result of the comparison under study, rather than as a confounder and its impact would then not constitute a bias.

5- Statistical analysis

Unpaired t tests of means were used in univariate analyzis involving continuous variables. Chi-square tests were used in univariate analyzis with categorical data. Multiple linear regression was used for all multivariate analysis. Models were developed specifically for each outcome. The principal independent variable was speciality of index consultant, with subspeciality = 0 and general internal medicine = 1. Women were coded as 1 in gender variables. Alpha error was set at 0.01 because of multiple testing concern and because of the possibility of underestimated variances due to a potential cluster effect. Consultants could be involved in many different patients' index visit, which may have in turn caused some cluster effect in the generation of subsequent referrals for their patients. To explore this possibility, generalized estimating equations was used to measure the degree of correlation for the principal outcome between patients seen initially by the same index consultant, and to evaluate the impact of this phenomenon on the width of the confidence intervals. Standard linear regression was prefered a priori because outcome events (subsequent referrals) were generated by any physicians these patients encountered, and not only the index consultants. Point estimates and 99% confidence intervals are provided for each multivariate analysis.

The distribution of the main outcome was studied (figure 2). Despite the skewness of the data, the use of multiple linear regression was justified by the relatively high frequency of outcome occurrence (38.6% of patients had at least one subsequent medical consultation), and the large number of observations. It allowed a proper estimation of the mean and its standard error for Gaussian-based confidence intervals, because of the central limit theorem. Any small gain in fit obtained with transformation of the data was judged to be more than offset by the loss in the ease of interpretation, which characterizes linear regression.

Figure 2: Proportion of patients who had subsequent medical consultations: frequency distribution



5.1-Model development

ADG groups variables and index consultant's year of graduation variables were entered as groups of variable. Previous pattern of services utilization variables were analyzed individually with multiple level categorization and log transformation. Level categorization and log transformation strategies were compared with untransformed data to determine which method could maximize the R2 value of a model in which the principal outcome was used as the dependent variable. They were left untransformed in the final regression models.

All non-grouped variables (with the exception of previous pattern of services utilization variables) were tested for interaction with the principal independent variable. Statistically significant interactions were analyzed graphically to verify if they were linear. We categorized the variables involved in significant interactions and calculated the mean of the residual values for each category of these variables, using a full regression model (without interaction terms and with the principal outcome as the dependent variable). The residual means were plotted as a function of this multiple level categorization for each variable involved in an interaction. Based on these graphic representations, we categorized these variables if their interaction was non-linear. The limits of these categories were based on the graphic properties of the interaction. Results of these model selection techniques are presented in the results section.

Residuals, tolerance, variance inflation and eigenvalues were studied for each outcome. Variables involved in a group or in a statistically significant interaction were forced in the models, others were kept in the model for the principal outcome if they reached a p value <0.01 or if they altered the estimated difference in the principal independant variable. Statistical analysis were done using SAS software.

6-Ethical considerations

The anonymity of patients and physicians was protected by third party linkage and encryption of identification numbers. Grouped data released from Statistics Canada rendered any detection of a particular patient almost impossible. No other ethical concerns were raised by this study.

RESULTS

1- Description of the study population[5]

A total of 46,158 patients were referred by a family physician of the source cohort, for a consultation with an eligible specialist. Among this group, 5,400 patients were excluded because they were seen by the index consultant in the twelve months preceding the index date. 7,608 patients were excluded because their index consultation took place less than three months before the end of the available follow-up. Finally, 186 patients were excluded for other reasons (temporary identification number, incomplete file, or long term care facility consultation). The resulting study population consisted of 32,964 patients. A description of the baseline characteristics of the study population is presented in table 5. Data specific to the five subspecialities constituting the subspeciality cohort are also presented.

Slightly more than one quarter (n = 8,756) of all patients were in the GIM cohort. In the subspeciality cohort, 47.0% were seen by a cardiologist, 27.2% by a gastroenterologist, 15.6% by a respirologist, 5.3% by a rheumatologist and 4.8% by an endocrinologist. Important differences in the setting of the index consultation were noted; the GIM cohort had a higher proportion of ICU/CCU patients (12.3% vs 5.5%) and of emergency-room patients (25.3% vs 18.9%), with a smaller proportion of outpatients (25.9% vs 40.3%), than the subspeciality cohort. Demographic characteristics showed little difference between groups, especially for gender, but GIM patients were slightly older on average (28.0% vs 24.1% in the old age category). A greater proportion of subspeciality patients resided in urban with tertiary care centers and they had a higher mean net educational level and family income than GIM patients.

Both cohorts had remarkably similar comorbidity scores and previous pattern of services utilization, despite variations between subspecialities within the subspeciality cohort. These findings reinforce the cohorts' comparability in terms of their past medical history and use of health resources.

[5] Within results presentation, tables, or figures, percentages may not always sum up to 100% because of rounding.

Table 5: Description of the patient population

	Gen. Internal medicine	sub-specialities	cardio	gastro	resp	rheum	endo
			subspecialities breakdown				
Number of patients	8 756	24 208	11 385	6 595	3 770	1 285	1 173
Patient characteristics							
1-Demographic (% of patients)							
Age category**							
<62 y.o.	49.8	54.8	48.8	63.0	49.7	68.3	67.9
62 to 72 y.o.	22.2	21.1	23.9	17.5	22.9	14.8	15.3
>72 y.o.	28.0	24.1	27.3	19.4	27.4	16.9	16.8
Gender (%women)	51.1	51.0	48.1	53.0	47.5	60.8	68.2
2-Geographical access to tertiary health care (% of patients)**							
Urban (0 km)	16.0	20.6	18.9	19.1	24.2	31.0	23.3
Intermediate (1 - 100 km)	54.5	54.4	53.4	58.8	53.7	48.2	47.7
Remote (>100 km)	29.5	25.0	27.7	22.1	22.1	20.9	29.1
3-Socio-economic status							
Net education level°	0.038	0.055	0.055	0.048	0.045	0.096	0.080
Mean family income ($)	52,550	56,228	57,155	57,390	52,449	53,556	55,757
4-Comorbidity (baseline period)							
Charlson comorb. score	0.85	0.83	0.79	0.74	1.21	0.62	0.85
5-Previous pattern of services utilization during baseline period (Number of events per patient)							
No of visits to physicians	24.3	24.5	23.7	24.3	27.2	23.0	25.6
No of visits to specialists	11.6	11.6	11.2	11.2	13.1	12.0	12.9
No of emerg. room visits	2.5	2.5	2.3	2.6	2.8	2.6	2.3
No of different physicians	8.8	9.4	8.9	9.7	10.0	9.2	9.7
No of acute hospitalizations	1.4	1.4	1.3	1.3	1.6	1.5	1.1
No of ICU/CCU admissions	0.17	0.17	0.24	0.09	0.13	0.10	0.14
Index visit setting (% of patients)							
Outpatient	25.9	40.3	33.7	45.6	38.3	60.9	57.0
Emergency room	25.3	18.9	21.6	15.5	15.6	32.5	8.6
Acute care hospital	36.5	35.3	35.5	38.4	41.5	6.5	28.3
ICU/CCU	12.3	5.5	9.2	0.5	4.6	0	6.1
Index consultant characteristics (% of patients*)							
Graduated before 1980	54.3	68.3	73.7	68.4	57.1	46.5	75.8
Women	17.9	5.0	3.0	4.0	6.8	10.8	18.3
Patients remaining available for follow-up (% of the cohort from 0 to 3 months)							
From 3 to 6 months	80.8	81.7	81.9	82.0	79.8	85.4	80.4
From 6 to 9 months	61.0	62.0	62.2	63.4	59.0	61.9	61.0

*Represent the percentage of patients seen by consultants with these characteristics.
°See methodology, section 4.1.1.2 for the definition of the scale (actual range: -0.39 to 0.61).
**The categorization of these varibles was based on multiple regression model requirements, as explained in the section 3 of the results presentation.

As expected, variations in comorbidity and previous pattern of services utilization were present among subspeciality groups within the subspeciality cohort, reflecting differences in severity and in case-mix from one subspeciality to another. The distribution of the patients among the 34 ADG groupings was similar in both study cohorts.

Differences were noted in index consultants characteristics as GIM cohort patients were more often seen by recently graduated specialists and by female physicians (17.9% vs 5.0%). From the consulting physician perspective (not shown), the 32,964 index consultations were performed by 968 different consultants; 223 in the general internist cohort (23%), and 745 in the subspecialist cohort (77%). The 32,964 patients of the study population were available for at least three months of follow-up by definition. Because of incomplete follow-up information and deaths, 26,860 patients (81.5%) and 20,351 patients (61.7%) remained available respectively from three to six months, and six to nine months after inclusion.

2- Principal outcome

2.1- Univariate analysis

Overall, the mean number of medical consultations per 100 patients was 75 in the three months following the index consultation, 26 from 3 to 6 months, and 23 from 6 to 9 months. During the first follow-up period, 38.6% of patients had at least one, and 17.5% had two or more subsequent medical consultations. The percentage with at least one medical consultation decreased to 15.7% for the second follow-up period, and to 13.6% for the third period. First, we compared the two cohorts using univariate analysis. (see table 6) The number of subsequent consultations in medical specialities was higher in the GIM cohort for the first three month period, equal for the second period, and lower for the third period. The differences expressed are small, both in absolute terms (7 additional consultations per 100 patients in the first three months, or 1 extra consultation per 14 patients) and in relative terms (a difference of 9.3% for the first period and of -13.0% for the last period when compared to the overall mean).

Table 6: Number of subsequent medical consultations per 100 patients: univariate analysis

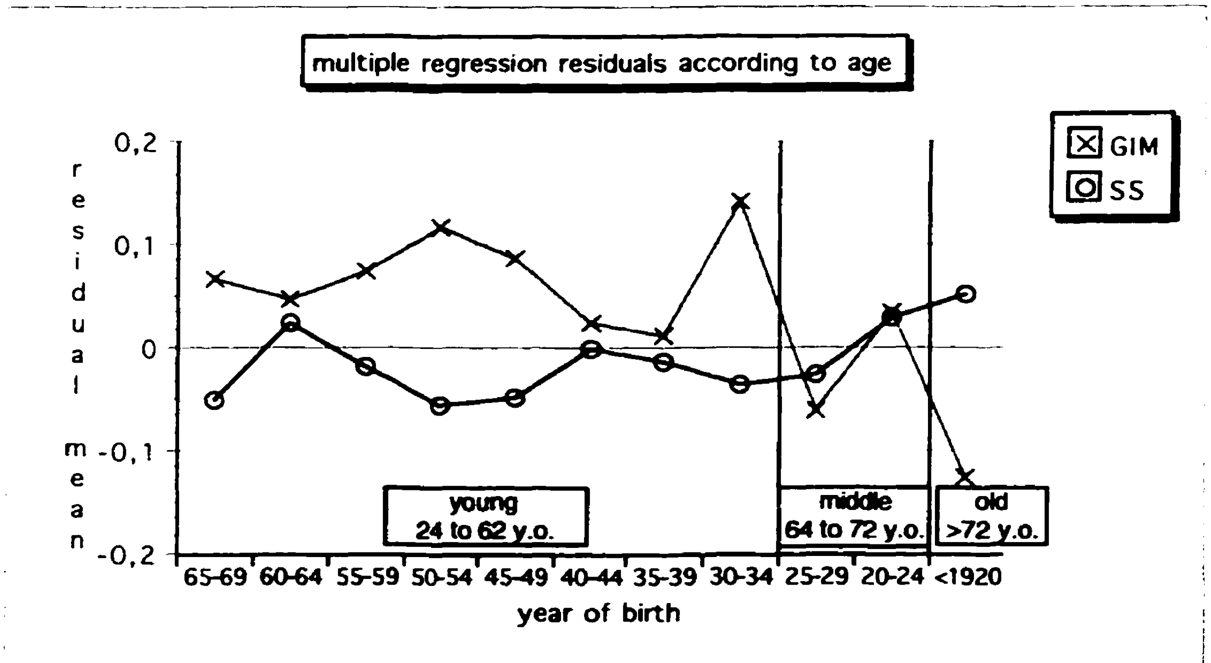
	GIM cohort	Subspeciality cohort	Δ	99% CI for Δ
No of consultations per 100 patients				
from 0 to 3 months	80	73	7	(2, 11)
from 3 to 6 months	26	26	0.5	(-2, 3)
from 6 to 9 months	20	23	-3	(-1, -6)

2.2- Results of the multiple regression model development

Three variables had significant interactions with the principal association under study; patients' age, distance from academic tertiary care cities, and setting of the index consultation.

Age, was divided into 11 categories to analyze graphically the nature of its interaction (these subdivisions represented the 11 years of birth categories from the data sources).(see figure 3) For each of these age categories, the residual means of a full model regression model were calculated in both cohorts (subspeciality (SS) and GIM).

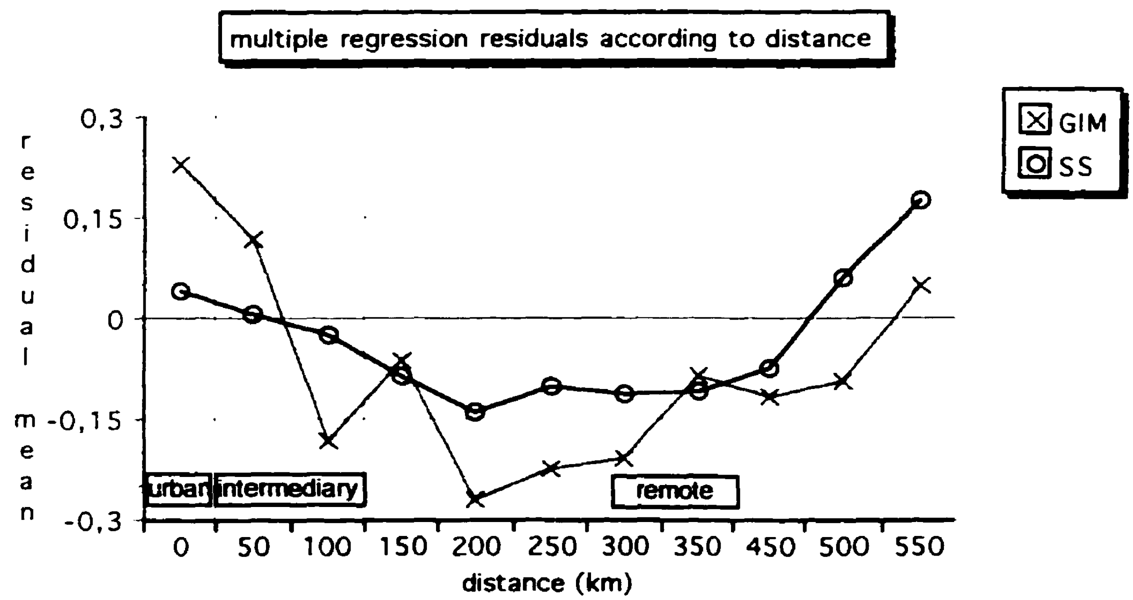
Figure 3:



From this graphical representation, it was found that the interaction between age and speciality was non-linear, and we decided to categorize age in three levels. The first involved the eight younger dates of birth categories (from 21 to 62 y.o.) which accounted for 52.4% of patients. The second involved the ninth and tenth categories (from 62 to 72 y.o.) accounting for 22.4% of patients. The third involved the eleventh category (>72 y.o.) accounting for 25.2% of the population. The middle age category was used as the reference. Interaction terms with speciality were put in for the first and the third category. To decrease residual confounding due to the width of these three categories, we introduced an extra variable for each category, defined as the difference between the age of the patient and the mean age of the category to which he/she was attributed. For the two age categories in which a patient was not included, the value of the corresponding residual variation variables were set at 0. For example, a 37 year old patient, who is in the young age category, was attributed -9 for young age category residual variation which equals the mean age of that age category (46 y.o.) minus his age (37 y.o.).

Non-linear interaction between distance and speciality was also found. We categorized distance in three levels; (see figure 4)

Figure 4:



1- academic tertiary care cities (distance = 0 km); 19.9% of patients,

2- intermediate areas (distance from 1 to 100 km); 54.4% of patients,

3- remote areas (distance greater than 100 km); 26.2% of patients.

The first group was used as the reference category.

The four setting categories were modelled as four dichotomous variables. The outpatient variable was chosen as the reference, and interaction terms were created for the other three.

2.3- Multivariate analysis

With multiple regression, statistically significant differences between the two cohorts were found in the first follow-up period. However, because of interactions, no single estimate of the difference can be reported to characterize the comparison under study. In other words, the difference between GIM and subspeciality cohorts changed according to the age of the patient, the setting of the index consultation, and the access to academic tertiary care. For this reason, results specific to strata of these determinants are presented.

The effect of speciality disappeared for the second and third period of follow-up (as opposed to univariate analysis), meaning that no differential impact of the index consultant's speciality was measurable in our data after three months. The impact of interaction terms involving speciality also disappeared and single estimates can be presented for these periods. Results are presented in table 7 for the first period and in table 8 for second and third periods.

In table 7, "Δ with GIM" expresses the estimated difference in the number of medical consultations per patient (in the three months following index consultation), that would result from the use of internists as index consultants, as compared to subspecialists. Positive results indicate an increased occurrence of subsequent consultations with general internists and negative results indicate a decreased occurrence with general internists. Because of interactions, the results are presented for 36 strata.

Table 7: Difference (Δ) in the number of subsequent medical consultations per 100 patients between general internal medicine and subspecialities, in the first three months after index consultation, using multiple regression**

Urban region

Setting	number of consultations measured*	≤62 y.o. Δ with GIM°	99% CI	62 to 72 y.o. Δ with GIM	99% CI	≥ 72 y.o. Δwith GIM	99% CI
outpatient	57	26	(14 , 37)	14	(1 , 27)	-2	(-14 , 10)
emer. room	116	43	(30 , 55)	31	(17 , 45)	15	(2 , 28)
acute care	130	26	(14 , 37)	14	(1 , 27)	-2	(-14 , 10)
ICU/CCU	204	10	(-7 , 26)	-2	(-20 , 15)	-18	(-35, -2)

Intermediate region

Setting	number of consultations measured*	≤62 y.o. Δ with GIM°	99% CI	62 to 72 y.o. Δ with GIM	99% CI	≥ 72 y.o. Δwith GIM	99% CI
outpatient	33	4	(-3 , 11)	-8	(-17 , 2)	-24	(-33 , -15)
emer. room	92	21	(11 , 31)	10	(-2 , 21)	-7	(-18 , 4)
acute care	92	4	(-3 , 11)	-8	(-17 , 2)	-24	(-33 , -15)
ICU/CCU	134	-12	(-26 , 2)	-24	(-39 , -8)	-40	(-55 , -25)

Remote region

Setting	number of consultations measured*	≤62 y.o. Δ with GIM°	99% CI	62 to 72 y.o. Δ with GIM	99% CI	≥ 72 y.o. Δwith GIM	99% CI
outpatient	22	-1	(-10 , 8)	-13	(-24 , -2)	-29	(-40 , -19)
emer. room	61	16	(6 , 26)	4	(-8 , 17)	-12	(-24 , -0.2)
acute care	66	-1	(-10 , 8)	-13	(-24 , -2)	-29	(-40 , -19)
ICU/CCU	85	-17	(-33 , -2)	-29	(-45 , -13)	-45	(-61 , -30)

** After adjustment for age, gender, region, comorbidity, ADG, PPSU variables, and education level of patients, setting of index visit, graduation year and gender of the index physician.
* Represents the number of subsequent medical consultations per 100 patients measured in the study population, in the corresponding region / setting, in the 3 months following their index visit.
°Gives the difference (Δ) in the number of consultations per 100 patients in the next three months that would result from use of general internists (GIM) as index consultants, as compared to subspecialists, according to the regression model. A positive result indicates an increased number of subsequent consultations with general internists; a negative indicates the opposite effect.

Table 8: Difference in the number of subsequent medical consultations per 100 patients, from three to nine months after index consultation, using multiple regression**

No of consultations per 100 patients	measured occurence*	Δ with GIM°	99% CI for Δ
from 3 to 6 months	26.1	-0.4	(-3.6 , 2.8)
from 6 to 9 months	22.6	-1.9	(-4.9 , 1.2)

** After adjustment for age, gender, region, comorbidity, ADG, PPSU variables, and education level of patients, setting of index visit, and graduation year and gender of the index physician.
* The measured occurence is the number of medical consultations per 100 patients that was measured in the study population for these time periods.
° Indicates the difference (Δ] in the number of subsequent consultations per patient that would result from utilization of general internists (GIM) as index consultants, as compared with subspecialists, according to the regression model.

When compared to subspeciality cohort, differences in the number of subsequent medical consultations for the GIM cohort varied from -45 consultations per 100 patients (>72 y.o. ICU/CCU patients from remote regions), to +43 consultations per 100 patients (<62 y.o. emergency room patients from urban regions). These differences would represent very important changes in some instances, when compared with the actual number of subsequent consultations per 100 patients that was measured in our study population, for corresponding strata of region and setting.

Region was an important factor in the comparison. Remote region patients had less subsequent consultations with internists in 8 out of the 12 strata (with the exception of young patients seen in emergency room) while urban region patients had more subsequent consultations with internists in 7 out of 12 strata (with the exception of ICU/CCU elderly patients). Age categories also had an impact on the difference between internal medicine and subspeciality, which was of similar magnitude to region. In the less than 62 years old age category, subspecialists' patients had less subsequent consultations in 5 out of 12 strata, no difference being found in five others, and the reverse association being present only in ICU/CCU setting in remote regions. However, patients 72 years old and over had more subsequent consultations with subspecialists in 9 out of 12 strata, no difference being found in two others and the reverse association being present in emergency room setting in urban regions. ICU/CCU patients were having a less or equal number of subsequent consultations in GIM cohort for all ages and regions strata. The reverse phenomenon was happening in the emergency room where internists' patients were having the same number or more subsequent consultations for all ages and regions strata, with the exception of elderly in remote regions. No global trend was predominant for acute care hospitalized patients or outpatients.

In summary, the difference between GIM and subspeciality patients is a function of region, patients' ages and setting. Even if these differences can be quite important relatively to the real occurrence measured in these strata, no overall systematic difference across the whole population can be noted. Overall for the 36 strata presented, GIM patients had more subsequent consultations (when compared to subspeciality patients) in 9 strata representing 21.6% of the population, less subsequent consultations in 13 strata representing 23.1% of the population, while no statistically significant difference was present in 14 strata representing 55.3% of the population.

2.3.1-Impact of other variables on the principal outcome

All other variables or group of variables (summarized in table 5) were found to have a statistically significant association to the outcome with three exceptions. The average family income lost its significance when net education level was entered in the model. The number of admissions to ICU/CCU during the baseline period added no other significant information once the other five previous pattern of services utilization variables were in the model. Residual age variation in the old age category added no information as we expected, because of its very small variability. These three variables were dropped in the development of the final model.

Setting was a strong predictor of the principal outcome. Outpatient, emergency room, acute-care hospital, and ICU/CCU were associated with the number of subsequent consultations in ascending order of frequency, ICU/CCU patients having nearly two times more consultations in the first three months than outpatients. Increasing age, particularly between the young-age and middle-age group, was also associated with an increase in consultations. Distance was inversely associated with the number of subsequent consultations; patients from intermediate regions having approximately 33% less consultations, and patients from remote regions having approximately 50% less consultations than patients residing in urban regions, on average. Female patients had a slightly smaller number (≈5% less) of subsequent consultations than men, while patients seen by female index consultants had a higher number (≈16% more) of subsequent consultations than patients seen by male consultants. Subsequent consultations increased with decreasing time since graduation of their index specialist (with the exception of the small number of patients seen by physicians who had graduated after 1988). Increasing Charlson comorbidity score was associated with an increased number of subsequent consultations. The same association was found for the number of visits to emergency room, acute hospitalizations, visits to specialists, and for the number of different physicians seen during the baseline period. ADG groupings were significantly associated with the outcome as a group, but we will not discuss their individual effects here. *(See appendix 3 for a detailed description of the regression model with all regression coefficients and their respective p values)*

3- Secondary outcomes

3.1- Total number of subsequent consultations

The total number of subsequent consultations consisted of all subsequent consultations to any subspeciality, as opposed to "medical" consultations that were limited to consultations to specialities within the internal medicine field. Medical consultations (the principal outcome) constituted 66.7% of the total number of subsequent consultations in our study population. Overall, the mean number of consultation per 100 patients was 112 in the three months following the index consultation, 42 from three to six months, and 37 from six to nine months. During the first follow-up period, 51.1% of patients had at least one, and 26.1% had two or more subsequent consultations. The percentage with at least one consultation decreased to 23.4% for the second follow-up period, and to 20.9% for the third period.

The same multiple regression model that was used to predict "medical" consultations was applied to the "total number" of consultations to assess changes in trends between the two outcomes. We calculated the 36 strata-specific differences between GIM and subspeciality cohorts, with their 99% confidence intervals (not provided with the text). When we compared "medical" with "total" subsequent referrals, the same trends were noted due to interactions of patient's age, distance to tertiary care, and setting of the index visit. *(See appendix 4 for a detailed description of the regression model results)* Older patients, or patients from a remote region, or those seen initially in ICU/CCU setting have fewer consultations if their index consultation is with a general internist as opposed to a medical subspecialist, while the opposite effect is found for young patients from urban region seen in emergency room.

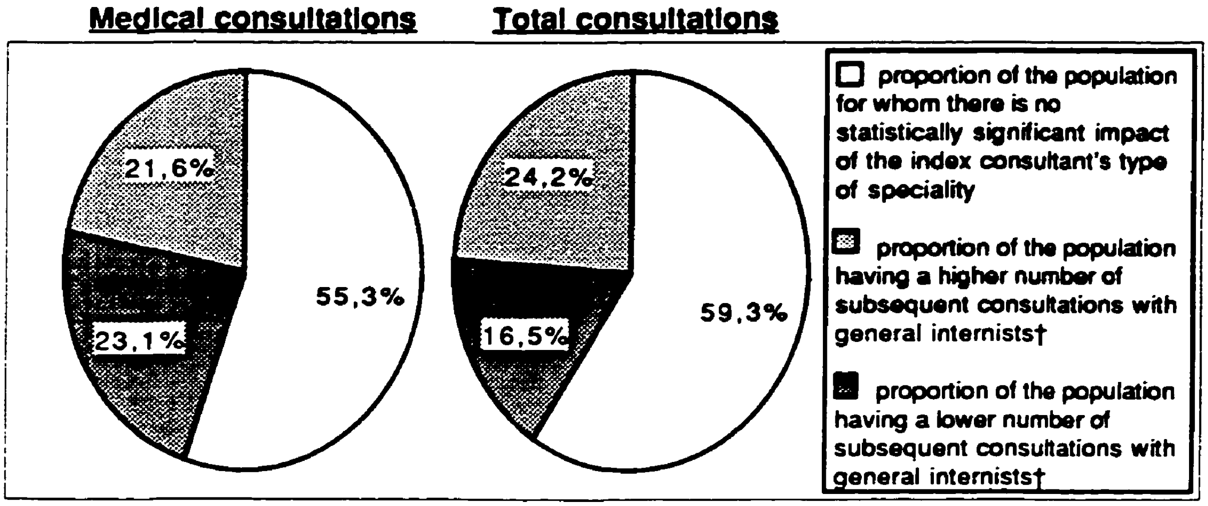
Overall, the effect of speciality on the number of subsequent referrals slightly decreases when we compare medical and total referrals. The proportion of the population having less referrals with general internists decreases from 23.1% to 16.5%, while the proportion of patients with no statistically significant impact due to speciality increases from 55.3% to 59.3%.(see figure 5) These small differences between the two outcomes could suggest that the effect of speciality is lessened when we consider all subsequent consultations instead of "medical" consultation. However, the general interaction trends and the global results are very similar for the two outcomes. They demonstrate that findings for medical and total subsequent referrals are generally consistent with each other.

3.2- Continuity of care

3.2.1-Usual provider continuity (UPC)

The most commonly seen physician in the first three months after index consultation was identified for each patient. This physician was a general practitioner in 39.4% of internal medicine patients and in 35.9% of subspeciality patients. This physician was from the same speciality as the index consultant in

Figure 5: Comparison of the effect of speciality on the number of "medical" versus "total" subsequent consultations; using multiple regression.



† when compared to subspecialists

42.4% of internal medicine patients and in 46.0% of subspeciality patients. Even if these differences were small, they reached statistical significance (Chi-square p value < 0.001 for each comparison). Because a bigger proportion of internal medicine cohort came from inpatient settings, we also identified the most commonly seen physician considering only outpatient visits in the computations. The usual provider was again more often a general practitioner in the internal medicine cohort than in the suspeciality cohort (51.1% vs 44.9%, p < 0.001 for the difference).

31 760 patients (96.3% of the study population) had at least one visit during the first three months after index consultation and were included in the computations (23 264 in subspeciality cohort and 8 496 in GIM cohort). Interactions with patient's age, setting of index consultation, and distance to tertiary care were again present. However, the difference between the two cohorts was the same whether patients were from an urban or a remote region, even if interaction was present for patients from intermediary regions. That explains why the differences between specialities (Δ) are identical for urban and remote region patients in strata-specific results provided in table 10. "Δ with

GIM" expresses the difference in UPC, that would result from the use of internists as index consultants as compared to subspecialists, according to estimates produced by the regression model. Positive results indicate an increased continuity among patients seen in consultation by internists and negative results indicate a decreased continuity. As an example, patients less than 62 y.o. from urban region, seen in ICU/CCU, had 2.7% more visits to their usual provider (among all their visits to any physician) on average when their index consultant was an internist, as opposed to a medical subspecialist. Measured mean UPC increased from urban (40.0%) to intermediate regions (42.2%), and to remote regions (46.6%). Differences in UPC between cohorts ranged from -2.6% to +8.4% according to strata *(See appendix 5 for a detailed description of the regression model results).*

The results show that the gain in continuity in the GIM cohort, when compared to subspecialities cohort, increases with age. The gain in continuity for GIM patients (when compared to subspeciality patients) also increases gradually with setting; from outpatients to emergency room patients, to acute care hospitalized patients, and finally to ICU/CCU patients. This could be interpreted as gain in continuity with increasing severity of acute medical problem(s) present at index consultation. Overall, out of 36 strata, patients initially seen by general internists had an increased continuity in 21 strata, a decreased continuity in 2 strata, while no statistically significant difference was found in 13 strata. These strata represented respectively 47.4%, 12.4%, and 40.2% of the study population. When compared to the results on the number of subsequent medical consultations, it can be noted that 47.4% had an increased continuity when seen by a general internist (as compared with a medical subspecialist), even if only 23.1% had fewer subsequent medical consultations. Similarly, only 12.4% had an decreased continuity with general internists while 21.6% had a higher number of subsequent consultations. These discrepancies could suggest that continuity of care does not depend only on the number of consultations, but also on other factors, that vary systematically between the general internists and subspecialists practices. However, the variations of the differences between specialities from strata to strata, were consistent for thecontinuity of care and the number of subsequent consultations (as example,

Table 10: Difference in the proportion of visits to the usual provider between internal medicine and subspeciality cohorts, in the first three months after index consultation, using multiple regression**

(% of visits)

Urban region (measured mean UPC = 40.0%)

	≤62 y.o.		62 to 72 y.o.		≥ 72 y.o.	
	Δ with GIM[º]	99% CI	Δ with GIM	99% CI	Δwith GIM	99% CI
setting						
outpatient	-2.6	(-3.9 , -1.3)	-0.7	(-2.5 , 1.0)	1.1	(-0.6 , 2.8)
emerg. room	-0.7	(-2.1 , 0.8)	1.2	(-0.5 , 2.9)	3.0	(1.4 , 4.6)
acute care	0.9	(-1.2 , 3.0)	2.8	(0.5 , 5.0)	4.8	(2.6 , 7.0)
ICU/CCU	2.7	(0.6 , 4.8)	4.5	(2.3 , 6.7)	6.3	(4.2 , 8.5)

Intermediate region (measured mean UPC = 42.2%)

	≤62 y.o.		62 to 72 y.o.		≥ 72 y.o.	
	Δ with GIM	99% CI	Δ with GIM	99% CI	Δwith GIM	99% CI
setting						
outpatient	-0.6	(-1.9 , 0.8)	1.3	(-0.4 , 3.0)	3.1	(1.4 , 4.8)
emerg. room	1.4	(-0.1 , 2.8)	3.2	(1.5 , 4.9)	5.0	(3.5 , 6.6)
acute care	3.0	(0.9 , 5.0)	4.8	(2.6 , 7.0)	6.6	(4.5 , 8.7)
ICU/CCU	4.7	(2.7 , 6.8)	6.6	(4.4 , 6.6)	8.4	(6.3 , 10.5)

Remote region (measured mean UPC = 46.6%)

	≤62 y.o.		62 to 72 y.o.		≥ 72 y.o.	
	Δ with GIM	99% CI	Δ with GIM	99% CI	Δwith GIM	99% CI
setting						
outpatient	-2.6	(-3.9 , -1.3)	-0.7	(-2.5 , 1.0)	1.1	(-0.6 , 2.8)
emerg. room	-0.7	(-2.1 , 0.8)	1.2	(-0.5 , 2.9)	3.0	(1.4 , 4.6)
acute care	0.9	(-1.2 , 3.0)	2.8	(0.5 , 5.0)	4.8	(2.6 , 7.0)
ICU/CCU	2.7	(0.6 , 4.8)	4.5	(2.3 , 6.7)	6.3	(4.2 , 8.5)

** After adjustment for age, gender, region, comorbidity, ADG, PPSU variables, and education level of patients, setting of index visit, graduation year and gender of the index physician. A positive result indicates an increased UPC with general internists; a negative result indicates the opposite effect.

º Indicates the difference (Δ) in the proportion of visits to the usual provider, that would result from the utilization of internists as index consultants as compared to subspecialists, in the three months following index visit, according to the regression model.

elderly patients had less consultations and they had a better continuity when seen initially by a general internists rather than subspecialists, as compared with other age strata).

3.2.2-Total number of different physicians seen

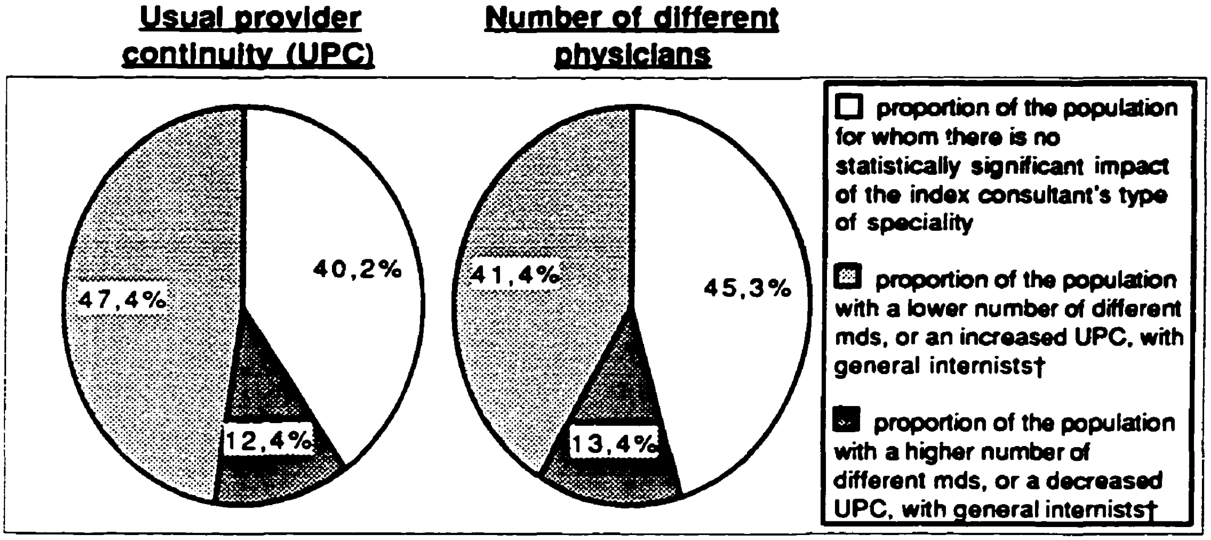
The total number of different physicians involved in the first follow-up period was also analyzed. The mean number of different physicians measured in the population was 7.51 MD per patient from urban regions, 6.41 MD per patient from intermediate regions, and 5.09 MD per patient from remote regions. Interactions with speciality of index consultant were again found for setting of initial consultation, patients' age, and region. Using multiple regression, strata-specific differences between GIM and subspeciality patients were calculated with their respective 99% confidence intervals *(See appendix 6 for a detailed description of the regression results).*

Differences between the two cohorts ranged from 0.96 more physician, to 1.36 less physician per patient in the GIM cohort. Translated into the estimated proportion of the population inside each strata, 41.2% saw a lower number of different physicians when seen initially by general internists, while only 13.3% of the population saw a higher number of different physicians. No statistically significant difference was present for 45.1% of the population. (see figure 6) The trend of differences from strata to strata, and the distribution of statistically significant differences between cohorts were very similar to what was found in UPC assessment. This can be interpreted as if the number of different physicians added virtually no additional information when compared to the findings from UPC.

3.3- Professional charges

During the three months following the index consultation, index consultant charges (the sum of the charges billed directly by, or on the request of the index consultant) were $173 per patient on average with an interquartile range of $76 to $302. Total charges amounted to $741 per patient on average with an interquartile range of $200 to $906. Total charges per patients (in the

Figure 6: Comparison of the effect of speciality on usual provider continuity (UPC), and on the number of different physicians seen during the first three months after index consultation; using multiple regression.



† when compared to subspecialists

first three months of follow-up), are presented according to region and setting in table 11. These two variables are strong determinants of charges as amounts measured decreased by 10% to 25% (depending on setting) from urban to remote region. As expected, total charges increased with setting; from outpatient to emergency room, to acute care, and to ICU/CCU. Charges for ICU/CCU patients were 3.3 to 3.5 times higher than for outpatients.

Table 11: Average charges per patient, billed by any physician (total charges), in the first three months after index consultation.

(canadian $)

Setting	outpatient	emergency room	hospitalized in acute care	ICU/CCU
Region				
urban	498	784	1060	1631
intermediate	374	707	964	1334
remote	371	642	954	1249

New multiple regression models were elaborated for charge outcomes. Even if age category is associated with each outcome, there is no significant interaction between age and speciality, meaning that the difference in total charges between GIM and subspeciality cohorts does not change according to the patient's age. However, interaction between speciality and distance is present. Setting is a major determinant of total charges, but an interaction with speciality is present only for ICU/CCU setting. This means that total charges change according to setting, but that the difference between GIM and subspeciality patients is similar in all settings with the exception of ICU/CCU. Accordingly, only six strata are used in the presentation of differences in total charges between GIM and subspeciality patients. (see table 12) Strata-specific differences in total charges, between subspeciality and GIM patients were computed according to the multiple regression model. They represent the difference in charges per patient, that would result from the use of general internists as index consultants compared to the use of subspecialists. Positive results indicate higher amounts for internal medicine patients, and negative results indicate lower amounts for internal medicine patients.

Table 12: Difference in total charges per patient, between general internal medicine and subspeciality patients, in the first three months after index consultation, using multiple regression*

(canadian $)

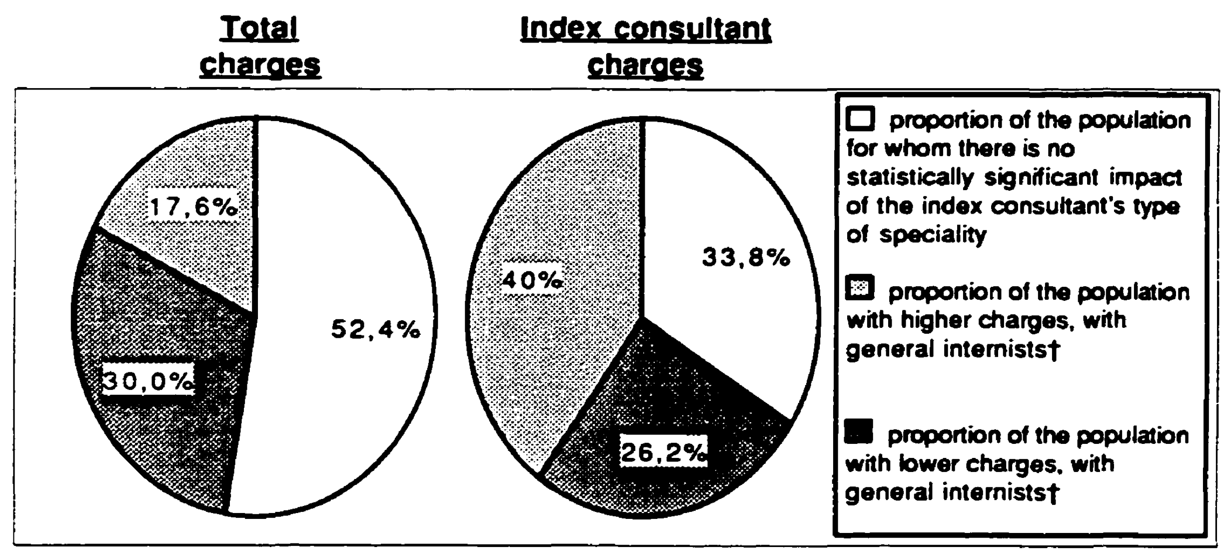
Setting	**ICU/CCU**		**other settings**	
	Δwith GIM[º]	99% CI	Δwith GIM	99% CI
Region				
urban	-54	(-167 , 58)	121	(27 , 191)
intermediate	-205	(-303 , -108)	-30	(-70 , 11)
remote	-258	(-360 , -156)	-82	(-137 , -27)

* After adjustment for age, gender, region, comorbidity, ADG, PPSU variables, and education level of patients, setting of index visit, graduation year and gender of the index physician. A positive result indicates an increase in charges with general internists when compared to subspecialists; a negative result indicates the opposite effect.
º Indicates the difference (Δ) in total charges, that would result from utilization of internists as index consultants as compared with subspecialists, in the three months following index visit, according to the regression model.

Total charges are increased by $121 for GIM patients from urban regions, when compared to subspeciality patients, with the exception of ICU/CCU where no statistically significant difference was found. However, total charges are decreased for GIM patients from remote regions, regardless of the setting (from $82 to $258 less). In intermediate regions, total charges are decreased for GIM patients from ICU/CCU ($205 less with GIM), while no difference is found for other settings.

We compared the effect of speciality on total versus index consultant's charges (see figure 7). For total charges, 30.0% of the population was comprised in strata for which charges were lower for GIM patients, 17.6% of the population was comprised in strata for which charges were higher for GIM patients, while 52.4% of the population was comprised in strata for which there was no statistically significant difference. These percentages were substantially different for index consultant's charges: 26.2% of the population was comprised in strata for which charges were lower for GIM patients, 40.0% of the population was comprised in strata for which charges were higher for GIM patients, while

Figure 7: Comparison of the effect of speciality on index consultant charges and on total charges, in the first three months after index consultation; using multiple regression.



† when compared to subspecialists

33.8% of the population was in strata for which there was no statistically significant difference. This difference between the two charges outcome could be interpreted as a demonstration that general internists tend to provide (or directly ask for) a bigger part of their patients' global care. However, this tendency does not necessarily produce an increase in total charges for these patients. If we consider all charges, 82.4% of patients would have had lower or equal amounts of charges with general internists than with subspecialists. As it was the case for other outcomes, the speciality of the index consultant had no significant effect on charges for a substantial part of the population, after multivariate adjustment *(See appendix 7 and 8 for a detailed description of results for regression models for charge outcomes).*

DISCUSSION

1- Impact of the consultant's type of speciality on the number of subsequent referrals

No general answer can be given concerning the differences in the number of subsequent consultations to other specialists, between patients seen initially in consultation by general internists or by medical subspecialists. Patients referred to internists and to subspecialists differed in their frequency of subsequent consultations in the first three months, after adjustment for other referral determinants. This difference was a function of patient's age, distance to tertiary care centers, and setting of the index visit. No overall advantage was present for either GIM or subspecialized care. No significant difference in the number of subsequent consultations was present after three months. In the first three months, older patients had less subsequent consultations when seen by internists while younger patients had more. Patients seen in the emergency room had less subsequent consultations in the subspecialities cohort, while ICU/CCU patients had more. Patients from urban regions had more subsequent consultations in the GIM cohort while patients from remote regions had less. These trends were both statistically significant, and clinically relevant, representing changes from -63% to 40%, relative to the frequencies actually observed in the corresponding strata of the population. The resulting strata-specific differences between cohorts were not statistically significant for 55% of the study population. Utilization of general internists in second line of care could reduce the utilization of subspecialized expertise in some situations, especially in remote regions. These results could reinforce the actual medical manpower policies regarding specialized care distribution in these areas. However these results could also be interpreted as evidence against a systematic utilization of internists as a second line of care since for a majority of patients, they either make no difference (55% of patients) or even increase (22% of patients) the subsequent utilization of consultations.

1.1- Influence of patients' age and setting of the index consultation

The changes with age and setting could be interpreted as two manifestations of the same reality. Older patients, and ICU/CCU patients are more likely to have multiple problems or to develop more complications than other patients on average. Inversely, patients presenting themselves at the emergency room, and younger patients should be more likely to have a single complaint or problem than other patients on average. The introduction of comorbidity variables provided adjustment for the chronic conditions of the patients, since they were measured using information preceding and including the index consultation. However, the subsequent evolution or the occurrence of complications was not included in the adjustment, because it was considered as part of the outcome of care. As a consequence, the broader field of expertise of internists could give them an advantage when they dealt with older people, or patients from critical care, allowing them to manage a greater proportion of their problems, even with comparable patients at presentation. For younger patients or patients presenting with better identified acute medical conditions, the deeper knowledge of subspecialists may have allowed them to address the complaints presented with less support from colleagues, when compared to internists who have less speciality specific and technical training.

Other explanations could also be considered. Internists may have been systematically less aggressive with elderly patients and requested less consultations for them than subspecialists. This could especially be the case if age distribution inside the old age category differed between the two groups. A higher proportion of patients greater than 80 years old for internists than for subspecialists inside this age category could have resulted in residual confounding by age through this mechanism. However, this could only partially explain the observed trend, since it would be unlikely to have an important impact in the other age categories where these trends have also been noticed.

In the emergency room-setting, it is possible that internists would have been referred patients with systematically more ill-defined symptoms than subspecialists on average, even after adjustment for their past-medical history. Patients with ill-defined symptoms are more likely to be referred to multiple specialists, and confounding may have resulted that may account partially for the increase in subsequent consultations for internists' patients in this setting.

However, if present, such a phenomenon should have also occurred in the other settings and could hardly explain the observed trends between settings. Also, we could have expected this to increase in elderly subjects, where the reverse impact of speciality was observed.

1.2- Influence of distance to tertiary care centers

Academic urban tertiary care hospitals benefit from a more important technological support and from the immediate availability of diverse specialized expertise. Family physicians have a choice of many different specialists for patients they want to refer, which is less often the case in intermediate and in remote regions. For this reason, residual confounding due to differential specificity of presenting symptoms is more likely to have had some impact in urban regions. If present, this confounding effect should have caused an increase in the number of consultations for GIM patients, when compared to the subspecialities' patients from urban regions.

The opportunity for general internists to perform themselves some technical diagnostic procedures may differ between regions. In intermediary or remote regions, general internists often provide technical expertise, such as endoscopy, which are performed by subspecialists in larger centers.(7) This differential access to these procedures may explain in part the increase in subsequent consultations for general internists patients from urban regions. However, Contandriopoulos et al (17) did not find systematic variations in the proportion of basic technical procedures done by internists between high- and low-population regions in Quebec, suggesting that this phenomenon probably did not have an important impact in the present study.

Other important factors may have played a role. The availability of a consultant may well have different consequences for internists than for subspecialists. The training and the practice of internists can influence their way of dealing with uncertainty differently than subspecialists, in which case internists could be more inclined to manage their patient with less support from their colleagues, even if they would have used it when available. Also, organization of services in remote region often causes hospitals to be staffed either by internists or by subspecialists, but not both. For example, the Rouyn Noranda hospital is staffed by a team of internists but no permanent medical subspecialist, while the Rimouski hospital does not have general internists but is staffed with various medical subspecialists.(118) Since small- and medium-size cities usually have only one hospital (as opposed to metropolitan areas), patients seen by internists outside metropolitan regions often have a more limited geographical access to susbspeciality care. In contrast, patients seen by subspecialists in these regions do have access to other specialities. This differential availability could have explained partly the trend observed between regions. It could be argued that these regional organizational factors are a part of the reality of specialized care in Quebec and that they should not be considered as confounders, but rather as part of the outcome that was measured in the present study. However, this argumentation reduces the generalizability of the present findings to other systems of care.

2- Quantification of the subsequent referral phenomenon

No evidence was available in the literature on the occurence of subsequent referrals after a first consultation. Studies on the economic impact of referrals (99-101) have suggested that referral could be a trigger for important resource use involving many other physicians, hospitals, and technical facilities. Initial referral represented only a minor part of the expenses. None of these studies documented the mechanisms by which these costs were generated and none were from Canada. The present study provides original elements of quantification of this phenomenon.

After being referred to one of the six specialities under study, 38.6% of all patients had one or more consultations to a medical specialist in the three months following the initial consultation. When we consider all consultations to any speciality, 51.1% of patients had at least one other and 26.1% had at least two other consultations in the following three months. Even with a decrease of approximately 50% in the two following three-month periods, the proportion of patients undergoing subsequent referrals in each period is far above the proportion of patients from primary care that are referred over one full year (referral rates vary from 1.6% (57) to 16.4% (60) of patients per year in the literature). For 100 patients referred for consultations to one of the specialities under study, 75 subsequent "medical" consultations took place on average in the following three months, and a total of 123 took place in the following nine months. If we consider all consultations to any speciality, almost 200 (n=191) subsequent referrals took place over nine months of follow-up, per 100 patients initially referred by their first line physician. These findings provide the first quantification of this poorly described phenomenon.

By design, our study population was not comparable to a primary care general population. The selection implied a first referral to specialized care, and our study population was expected to have more medical complaints and increased need for diagnostic or therapeutic specialized expertise, when compared to the general population. This was demonstrated by previous pattern of services utilization, where 44.6% of patients were hospitalized in acute care (and 9.5% in ICU/CCU), 44.3% had two or more visits to an emergency room, and 49.5% had 5 or more visits to a specialist in the 18 months preceding the index consultation.

It is not possible, from the information gathered in the present study, to determine if the subsequent referrals measured were justified by the clinical condition(s) of the patients involved. From our literature review, we found evidence to suggest that the proportion of "appropriate" referrals is similar whether the referral rates are high or low.(80-81) However, this evidence was from primary care and we don't know if it can be generalized to the context of the present study. The number of "appropriate referrals" in our population could have been greater, less, or the same as in primary care. The present study raises this question but, whatever the answer to this question is, our results demonstrate how important subsequent referrals can be in health-care human resources and budgetary planning. This study shows that a first referral can be considered as an initial step to a series of events. It also suggests that what happens after a first consultation may have even more importance, in terms of costs and human resources, than the initial consultation.

3- Documentation of the cascade effect

The "cascade effect" following a first referral has been described in case reports (47), but no quantification is available in the literature at this point. The present study documents and quantifies this phenomenon. Increased medical activity takes place in the first three months after the initial consultation. This activity decreases steeply in the second period and stabilizes during the third period, approximating the baseline level for this population. The number of subsequent medical consultations decreases by 65% in the second follow-up period, and by 69% in the third, when compared to the first follow-up period. The same pattern is observed if we consider the total number of referrals (not provided in the results section), which include all procedures billed by a physician on the request of another physician (it includes consultations, but also other types of visits, billings for X-rays, and nuclear medicine procedures that were requested by another physician). They show a 67.9% decrease from the first to the second period, but only a 4.1% decrease from the second to the third period. These results show that a "cascade" of events occurs after the initial referral to a specialist, by a family physician. They also show that it is an acute phenomenon occurring mainly in the first three months of follow-up.

It could be argued that the entire nine month period should be included in the "cascade" time window, since the frequency of consultations remained high even in the third follow-up period. However, the frequencies observed in the two last periods cannot be compared to frequencies published in the literature, because of the selection of our population. They have to be compared to baseline information of our study population. Baseline utilization pattern showed an average of 1.9 visits to specialist per patient per three months, 0.41 visits to emergency room per patient per three months, and 0.23 hospitalization in acute care per patient per three months. Considering that some of the baseline specialist visits were consultations, and that some hospitalizations or visits to emergency room should have led to specialized consultations, these baseline levels of service utilization probably correspond to the 0.37 subsequent consultation per patient (37 per 100 patients, see section 4.1 of the results) that we observed in our cohort during the last follow-up period. Another argument for the short duration of the cascade effect is the change of impact of certain referral determinants over time in our study. Referral determinants that were linked directly to the index consultation, such as speciality of the consultant, his/her gender, his/her graduation year, and the setting of the index visit, were strong predictors of subsequent consultations in the first three months of follow-up. These four determinants either completely lost their statistical significance (the first three), or kept a borderline statistical significance (setting of visit) while losing more than 95% of their predictive power after three months of follow-up. Other determinants such as geographical access and age, that were not characteristics of index consultation, remained significant even at nine months. This observation tends to demonstrate that the index consultations lose their measurable impact after three months.

The cascade effect, as described by Mold and Stein (47), implied a causal link between the initial consultation and the cascade of events following it. Our findings document the presence of a cascade effect following the index consultation. However, it is not possible to conclude from our data, that such a causal link was present. The index consultation could have had causal influence on subsequent referral occurrences but, it could also have been a marker for another condition (or disease), which explained the need for subsequent referrals. We propose that the terms "cascade effect" should apply to the series of event that we described, even though our definition of this concept slightly differs from what was published originally.

4- Impact of the consultant's type of speciality on continuity measures

Continuity of care measures differed between patients initially referred to internists and to subspecialists, after adjustment for other referral determinants. As for the number of different physicians, this difference was in function of a patient's age, distance to tertiary care centers, and setting of the index visit. The proportion of all visits made to their most prevalent physician was higher for internal medicine patients in 21 of the 36 strata required for the analysis (these 21 strata represented 47.4% of the study population). No statistically significant difference was present in 13 of the 36 strata (40.2% of the study population).

The advantage in usual provider continuity (UPC) for the GIM cohort was higher with elderly patients, and increased from outpatient to emergency room, acute care, and ICU/CCU setting, in ascending order. Up to 8.4% more visits to the usual provider, in proportion, were made by GIM patients, when compared to subspeciality patients, which represents a 20% increase relatively to the mean overall UPC of 42.9% of visits. A gain in usual provider continuity for subspeciality patients was noted in only two strata (12.4% of the study population). Results about the different number of physicians were very similar to UPC findings. We consider that they do not provide any supplementary information to UPC results. Internal medicine patients had a general practitioner as their most prevalent physician slightly more often than subspeciality patients (39.4% vs 35.9%). Accordingly, the increase in continuity for GIM cohort was not due to the fact that general internists more often took over the management of the patients themselves, thus becoming the most prevalent physician for their patients.

These results could be interpreted as a demonstration of an improved continuity of care, on average, for the GIM cohort, with variations of this advantage according to age, setting, and region. Continuity of care was increased for elderly and critical care patients in the internal medicine cohort, and for younger outpatients in the subspeciality cohort. These results appear to be consistent with the findings on the difference in the number of subsequent consultations in these subgroups. However, the proportion of patients initially seen by general internists who had an increased continuity (47.4%), is quite different from the proportion of patients who had less subsequent consultations when seen initially by general internists (23.1%). Continuity of care was improved for patients seen initially by general internists in some strata of the population who had similar number of subsequent consultations whether seen initially by an internist or a subspecialist. This suggests that general internists may have an impact on their patients' continuity of care, that does not depend exclusively on the number of subsequent consultations.

However, these findings have to be analyzed cautiously. In the literature, UPC has been used mostly in the context of primary care. It has been validated only once against outcomes of care in the context of secondary care.(93) To be included in the present study, all patients had to be referred from primary care physicians. Accordingly, our population did not constitute a primary care cohort. It would seem logical that the advantages of increased continuity described in the primary care literature, also apply to population of different levels of care, as demonstrated in the study by Lofgren et al (93). But this is the only direct evidence documenting the effect of continuity on other levels of care. Consequently, the generalization of the global findings reported in the literature review to the present context is debatable and should be addressed in future research.

It would be highly likely, from a conceptual point of view, that continuity of care increases as the proportion of care delivered by a single physician increases (the mathematical value of UPC can be directly interpreted as that proportion). But it is not certain that UPC is an appropriate measure of continuity in other settings than outpatient care. UPC has also been criticized for its high correlation with level of utilization of services (patients with higher number of visits have smaller proportion of these to one single physician on average) (130). In our study, we found UPC scores to decrease from outpatient, to emergency room, to acute care, and to critical care, which would confirm this observation. This could have acted as a confounding factor, since the proportion of patients in each setting was substantially different between the two cohorts. We provided specific results for each setting to handle confounding by this differential utilization level.

5- Impact of the consultant's type of speciality on charges

Two different measures of charges have been computed: index consultant charges and total charges. These charge variables included physicians' billings for our patient population. They did not include costs related to hospitalization or to ancillary tests other than the associated amounts paid to the physicians. Total charges should be correlated with total costs but no direct conversion can be made from charges to general costs, since the proportion of total costs that is devoted to physician billings may vary according to setting or other determinants of care.

Interesting discrepancies were noted between the two measures of charges. In multiple regression models, charges billed directly or on the request of index consultant were higher for internal medicine patients in 40% of the population. The reverse trend was observed only in remote regions. These differences, when compared to the amounts measured in these strata, represented increases of up to 34% in index consultant's charges for internal medicine patients, when compared to subspeciality patients (not provided in the result section). When total charges were considered (all charges billed by any physician), higher charges for GIM patients were present in only 17.6% of the population. These results show that more patients would have lower total charges with general internists as index consultants (30.0%) than with subspecialists (17.6%). The proportion of the population for whom there was no difference in charges between the two cohorts increased from 33.8% for index consultant's charges, to 52.4% for total charges. The most plausible explanation for this discordance would be that general internists, on average, do manage a greater proportion of their patients' problems themselves, thus asking directly more tests and other procedure than subspecialists. However, this would not influence the total number of procedures or interventions done for these patients, as demonstrated by total charges findings. This could also explain why, continuity of care results seem to be more favourable to GIM patients, when compared to results about the number of subsequent referrals which show no overall advantage for either cohort. If internists tend to do a bigger part of the management themselves, less follow-up by other specialists would be needed and, accordingly, increased continuity could be obtained even with a similar total number of subsequent referrals.

With total charges, the trends noted between strata (relative decrease of expenses for internal medicine patients from remote region and in ICU/CCU, relative increase of expenses for internal medicine patients from urban region) were consistent with results obtained for a number of subsequent consultations and for continuity.

6- Impact of other referral determinants

It was not the principal purpose of this study to analyze the impact of other determinants of referral. We included these to adjust for differences in the populations of patients seen by general internists and by medical subspecialists. We compared the influence of these covariates on our outcome from what has been published in the literature. All the determinants that we included were significantly associated with the outcome on univariate analysis. In the multivariate analysis, average income did not reach statistical significance. As expected from the literature review, increasing age (although it was non linear), urban site of residence, increasing comorbidity, and decreasing physician experience were also found to be associated with an increased number of subsequent consultations in the present study.(53,56,58,60-64,68) There was no consensus on the impact of gender and SES in the literature.(56,58,61) Male patients and patients with a higher education level had an increased number of consultations in our study. Gender of the physician has not been described as a determinant. In the present study, patients seen by female consultants had a higher number of subsequent referrals. The setting of the consultation was associated with the outcome in an intuitively logical sequence: outpatient, emergency room patients, acutely hopitalized patients, and critical care patients had more subsequent consultations in an ascending order.

7- Limitations of the present study

An original approach was used to compare the impact of two types of specialized care on subsequent referrals for consultation. To address this question, we had to adapt concepts and tools utilized in different systems of care, or in different levels of care. This study should be considered as an exploratory step into the knowledge and the understanding of the differences observed between these types of specialized care. It is at the hypothesis generating level on the research cycle. The findings underlined the inherent complexity of referral practices and their determinants.

7.1- Composition of the two cohorts

In this study, we described and compared a cohort of patients referred by family physicians to general internists to a cohort of patients referred to five predetermined types of subspecialists. Neither the proportion of subjects recruited in both cohorts nor the proportion of patients recruited in each subspeciality group were influenced by a predetermined study selection process. The resulting patient mix of each cohort was a direct consequence of the naturally occurring process of regular care by family physicians from the source cohort. The determination of the speciality of the index consultant may have been subject to misclassification because of the double certification of internal medicine subspecialists in Quebec.[6] Physicians are not allowed to bill in different specialities simultaneously at the RAMQ, and general internists have important restrictions in the total amount of technical procedures they can bill during each year in Quebec. Most subspecialists earn a substantial part of their income from technical procedures, and it would be unlikely that subspecialists choose to bill as internists, with some rare exceptions. This missclassification should be non-differential in relation to the principal outcome. Accordingly, its effect, if present, should be small and bias the results toward the absence of difference between cohorts.

Subspecialists rarely refer to general internists, while general internists often use subspeciality expertise. It can be argued that this phenomenon could result in a decreased opportunity for subsequent referral in the subspeciality cohort. However, general internal medicine is only one of the twelve medical specialities that are included in the principal outcome definition, and subspecialists <u>can</u> refer patient to any specialist they choose. The eleven other medical specialities that are preferred by subspecialists for their patients, can be considered as alternative choices to general internal medicine referrals. Thus, the small use of general internal medicine referrals by subspecialists should not represent a real decrease in opportunity for subsequent referral and should not impact on global utilization of subsequent referral by subspecialists. It should not result in confounding in the present study.

[6] In Quebec, subspecialists have to be certified both in internal medicine and in their respective subspeciality. See section 2.1 of the literature review.

Some general internists have differentiated their practice patterns after years of practice, eventually providing care almost limited to one subspeciality area. However, even if they loose in part their general approach to care in this process, they do not have subspeciality training and are not subspecialists. This restriction process is a part of the reality of general internal medicine practice and does not constitute real missclassification, even if it should decrease the theoretical polyvalence of general internal medicine care. Some medical subspecialists provide general internal medicine care to their patients, either through shared "on-call" schedules or inpatient care with general internists or other subspecialists, or because they choose to do so for their global practice. This phenomenon would increase the polyvalence of medical subspecialists and potentially decrease the number of subsequent referrals in the subspeciality cohort of patients. These practice patterns are thought to be infrequent and studies are being done to obtain data on this issue.(7) This phenomenon is a part of the reality of subspeciality practice and could be considered as a potential strenght of suspeciality care delivery. Accordingly, it should be considered as part of the outcome and does not constitute real missclassification.

7.2- Ascertainment of referrals

Identification of consultations was done through analysis of physician claims inside the physician claims database provided by the RAMQ. The physician claims database information must satisfy internal validity checks for physicians to be reimbursed. A validation study (104) of this database showed very good accuracy (97.8%) for the required information and specifically for the service code. Because of these findings, and because specialists are not paid for the full amount of a consultation if they do not provide the name of a valid referring physician, we are confident that the selection process, requiring the identification of a referring physician, and of a consultation claim, did not suffer from important misclassification. The exclusion of patients seen in the previous year by the same physician ensured that the patients included in the present study were new patients to these index consultant. Even if they were seen by these consultants more than one year before index consultation, it could be considered that sufficient time had elapsed since the last encounter, and that they had benefited from a new evaluation of their situation.

Outcome determination is also likely to be accurate because it relied on the identification of consultation claims from the physician claims database. Subsequent consultations asked by any physician for a study patient were included because of the multiple potential mechanisms involved in the generation of subsequent consultations (see section 3.1 of the methodology).

7.3- Adjustment for case-mix and comorbidity

Information on diagnostic codes is not required on physician claims at the RAMQ. Its validity has not been documented directly. The Charlson comorbidity index and ADG groups were computed using this information and may have been subject to misclassification. From the literature, we know that the Charlson index has been validated with administrative databases, including a Canadian database.(119-123) It also has been validated as a predictor of mortality using RAMQ data.(124) However, diagnostic codes information from administrative data has been shown to have lower sensitivity than chart based data.(126) Considering that the specificity of the diagnosis was acceptable (> 90%),(125) we included information from a longer baseline period in order to increase the sensitivity by increasing the number of claims potentially available for each patient. This approach, though logical, has not been validated. The comparison of specificity and sensitivity of administrative data, using different lengths of follow-up, with discharge data and prospectively collected data could be a topic for future research. Consequently, we were not able to evaluate accurately the degree of misclassification present with these data.

Insufficient case-mix and comorbity adjustment are important threats to the validity of our findings. However, it is unlikely that physician from specialities involved in the present study, systematically differ in the accuracy of the diagnoses reported on their claims from one speciality to another. However, even if this missclassification was non-differential between cohorts, it may have lead to residual confounding by case-mix and comorbidity. The high specificity but low sensitivity of the diagnostic codes are likely to have produced some underestimation of the severity of cases, and a greater missclassification for sicker patients than for healthier patients. According to Charlson score and to previous pattern of services use variables, both cohorts were similar in the case-mix of their patients. However, general internal medicine patients were more often hospitalized in acute care beds or in ICU/CCU than subspeciality patients, suggesting sicker patients on average. It is therefore possible that residual confounding by case-mix and comorbidity underestimated the severity of illness of general internal medicine patients, which may have led to an overestimation of the number of subsequent referrals for internists patients, when compared to subspecialists patients.

Previous pattern of service use (PPSU) variables indirectly provided very important information on the previous health status of patients. The data used to compute them was of much better accuracy because it relied on required fields from physician claims, and no diagnostic information was used in them. As a group, they explained a greater proportion of outcome variation than comorbidity or ADG categories in the present study. In addition to true comorbidity, they also provided an indirect measure of the propensity of patients to use health services. We believe that, as a group, case-mix and comorbidity variables provided a good estimate of the health status of our study population.

7.3.1-Differences in the specificity of symptoms at index consultation

Even with a satisfactory adjustment for case-mix characteristics, patients may have differed systematically as to the specificity of the symptoms they presented at the time of the index consultation. This could be the case especially for patients from an urban region, where either general internists or subspecialists are readily accessible (see section 1.2 of the discussion). Patients with ill-defined symptoms may have been referred more often to general internists because they are identified as the best resource in these situations. These patients are more likely to necessitate multiple investigations or consultations than patients with clear-cut diagnoses. Information about the type of presentation was not available through our databases.

Confounding may have resulted from this phenomenon, which should have improperly increased the number of subsequent referrals in the GIM cohort, when compared to subspecialities' cohort. No quantification of this phenomenon was possible from our databases. This confounding phenomenon would have been present mostly in urban regions. It should not have affected remote region patients as strongly because, for patients from these areas, both general internists and subspecialists are often not immediately available at the same hospital. Consequently, in these regions, subspecialists and general internists cohort of patients should have included their share of patients with ill-defined symptoms. This phenomenon may explain partially the effect modification of geographical access on the principal association under study.

7.3.2-Impact of case-mix and other referral determinants on multiple regression results

While acknowledging limitations in the case-mix adjustment of the present study, certain findings support the validity of our methods. The speciality of the consultant appeared as a significant predictor of the outcome even after three and six months in univariate analysis. We observed that after adjustment for confounding, it completely lost its significance after three months, while other determinants such as age and comorbidity remained significant. It was expected "a priori", that a single consultation to one type of specialist, when compared with another one, would have a greater impact on the care received by a patient in the initial period after the consultation, and that this impact would diminish over time. We interpreted this change between univariate and multivariate results as a sign that the confounding adjustment through the regression model was working effectively. The observation that other known referral determinants were found to be significant predictors in this study also reassured us on the general methodology used.

The different outcomes still showed relatively concordant results, that appeared coherent with theoretical advantages of general and subspecialized internal medicine care. Because no unique answer could found to the research question, the results could even be interpreted as evidence for a midpoint compromise between these two types of care. There was a decrease in the number of subsequent consultations, in total charges and an increase in continuity of care for internal medicine patients in the old age category and in critical care. It can be associated with the wider expertise of general internists, that could confer some advantage in these situations. There was an increase in the number of subsequent consultations, and in total charges for internal medicine patients in the young age category. Young patients are more likely to have a single circumscribed problem that can be comprehensively addressed by a subspecialist. These results show that various types of training may provide advantages in different situations. These complex findings are consistent with theoretical expectations of the subpopulation in whom internal medicine care would provide the greatest benefit. As such, they can also be interpreted as an argument for validity of the findings.

8- Other important considerations in the interpretation of the results

8.1- Limited evidence on quality of care measures

A decrease in the number of subsequent referrals would represent a desirable result only if outcomes of care are maintained or improved. We could not evaluate the impact of increased or decreased number of subsequent consultations on outcomes of care. Continuity has been associated with quality of care in the literature but, this was studied mostly on other levels of care (see section 4 of the discussion). Accordingly, decreases or increases in subsequent consultations as we observed, are to be interpreted very cautiously in the global appreciation of quality of care.

8.2- Comparability of appropriateness of care between cohorts

The data sources did not allow assessment of the appropriateness of referral. In this study, we assumed that the proportion of "appropriate" referrals, given the expected differences in expertise between specialities, would be similar between study groups (see section 4.1.8.1. from the literature review). We assumed that the differences observed were the result of differences in training or in the approach of patient care, that would vary systematically between cohorts. We could not verify these assumptions but, whether they were verified or not, we measured what could be considered as the impact of real practices by average physicians with each cohort of patients, rather than the theoretical impact of what should be the expertise of any speciality. Discrepancies between optimal practices and real practices, considering the objectives of training in each speciality, could be a topic for future research.

8.3- Independence of the data and variability of the results

In the present study, 968 different specialists were involved in the 32 964 index consultations. The average number of patients per index specialist was 34 (39 in internal medicine cohort and 32 in subspeciality cohort). However, because of the definition of the principal outcome, subsequent consultations could be requested by any physician encountered by study patients. In the present study, only 16.3% of total subsequent consultations were generated directly by the index consultant during the first three months of follow-up. This proportion decreased to 10.6% for the whole study period of nine months. Consequently, the majority of subsequent consultations were requested by a variety of physicians, which should considerably limit any cluster effect. The degree of correlation for the principal outcome between patients seen initially by the same index consultant was r= 0.04, the working correlation being estimated in GEE analysis. Also with GEE, we evaluated the impact of this potential cluster phenomenon on the width of the confidence intervals. Standard errors obtained through GEE were on average 9% bigger than standard errors obtained through multiple linear regression for the corresponding regression coefficients. In the present study, ninety-nine percent confidence intervals were used to evaluate the statistical significance of the results presented. Consequently, the Z score required to achieve significance was 2.576, which represent a 31% increase in comparison with a ninety-five percent confidence interval Z score of 1.960. The ninety-nine percent confidence intervals used in the present study should have prevented potential type 1 errors generated by underestimation of standard errors from clustering effects.

8.4- Generalizability of the findings

Data from real life practice was used for this study. The inception cohort was composed of nearly one fifth of Quebec's population, covering all regions, and all age groups. The inception cohort was followed between 18 and 30 months, using data from a universal health insurance plan. As opposed to many of the studies cited, the present study was not restricted to particular settings of care, or to certain insurance plans. As a consequence, the subsequent referral phenomenon, and of the cascade effect that characterizes it, are likely to be generalizable to the Quebec population, and to other populations using similar systems of specialized care delivery (such as other Canadian provinces). However, the direct generalizability of these findings to other countries is limited by important differences in systems of care, especially in the cases (such as United States) where internists and subspecialists play a substantially different role in health care services delivery.

Generalizability should be preserved even if all patients were initially referred by newly licensed family physicians. Referral practices can be affected by the experience of primary care physicians, but it seems unlikely that this factor would produce an important impact on the course of patients following their index consultation visit in the present study. Many physicians were involved in the follow-up of each patient (n=6.3 different physicians on average per patient), and, in a majority of the cases, these family physicians were not the most prevalent physician for the patients they referred. Most of subsequent referrals were required by other physicians. It would then become very unlikely that experience of the physician involved in the initial referral, would play a significant differential effect between the two cohorts of patients, in the generation of subsequent referrals.

8.5- Future research directions

The present study raises many questions. The main research question should also be readdressed through other designs, that could limit potential biases discussed previously. As example, it would be interesting to compare subsequent referral between hospital deserved by teams of subspecialists and general internists, selecting hospital with comparable catchment areas, demographic characteristics, and geographical availability of tertiary care resources. Selection bias through differential symptom specificity would then be greatly limited. Quality of care could be studied through chart audit for specific diagnostics in these hospitals, looking mainly at elements of the process of care, such as confomity to standard practice and lenght of stay. Some outcome of care data could also be prospectively studied for these selected populations. Such reseach could complement existing evidence that was not gathered specifically to address these issues, or that did not come from the canadian system of health care and physician training. (33,38,131)

CONCLUSION

The assumption about the ability of general medicine care to lower the use of subsequent referrals was generally not verified in our study. The reality appeared much more complex, and showed that the impact of general internal medicine care varied greatly with the age of the patients, setting of care, and distance to academic tertiary care centers, when compared to subspecialized care. Depending on the situation, general internal medicine care was associated with a decreased number of subsequent referrals, while in other situations, it could represent a supplementary and likely unnecessary intermediate step between primary and subspecialized care. Similarly, important variations in charges and in continuity were observed between strata of the population, even if continuity of care seemed to be generally greater in the internal medicine cohort of patients. The findings of this study, although exploratory, constitute a warning against oversimplification of the respective effect of general and subspecialized internal medicine care, on subsequent resource use, continuity of care, and professional charges.

We quantified the number subsequent referrals after a first consultation. We demonstrated that this phenomenon was frequent and that it was, on average, of even greater importance in terms of use of specialized care resources than the primary referral itself. Our results confirm the existence of the "cascade effect" at the scale of populations of patients, while providing some data for its quantification.

The political decisions made in the recent years to promote general internal medicine in the province of Quebec were partly justified by the need for an improved geographical access to specialized care, and by the intent to institute a second line of care between general practitioners and subspecialists. The debate about the place of general internal medicine, its training requirements, and its role compared to medical subspecialities is presently ongoing. This study outlined the need for research in this area, at a time when political decisions are being made with very little evidence to support them. We documented that subsequent referrals constitute an important aspect of the potential impact of specialized care. Future research should be aimed at the verification of our findings, the exploration of the impact of various types of specialized care on outcomes, and on the development and validation of epidemiologic tools for this specific area of research.

APPENDIX 1

Charlson comorbidity index
List of diagnostic codes (119)

Diagnosis	Code	weight
1- Myocardial infarction	410-410.9	1
	412	
2- Congestive hearth failure	428-428.9	1
3- Peripheral vascular disease	443.9	1
	441-441.9	
	785.4	
	v43.4	
4- Cerebrovascular disease	430-438	1
5- Dementia	290-290.9	1
6- Chronic pulmonary disease	490-496	1
	500-505	
	506.4	
7- Connective tissue disease	710.0-710.1	1
	710.4	
	714.0-714.2	
	714.8	
	725	
8- Peptic ulcer disease	531-534.9	1
9- Mild liver disease	571.2	1
	571.4-571.6	
10- Diabetes	250-250.2	1
	250.6	
11- Diabetes with chronic complications	250.3-250.5	2
12- Hemiplegia or paraplegia	344.1	2
	342-342.9	
13- Moderate or severe renal disease	582-582.9	2
	583-583.7	
	585.0	
	586.0	
	588-588.9	
14, 15,16- Any non-metastatic solid tumor,	140-172.9	2
including leukemia or lymphoma	174-195.8	
	200-208.9	
17- Moderate or severe liver disease	572.2-572.8	3
	456.0-456.2	
18- Metastatic solid tumor	196-199.1	6
19- AIDS	042-044.9	6

Note: diagnostic coding in the RAMQ database is limited to 1 decimal point. This explains the very slight differences we had in four of the above codes, when compared to the list published by Deyo et al.(119)

APPENDIX 2

The Ambulatory Diagnostic Groups (ADG) and common ICD-9 codes assigned to them (127)

ADG	ADG designation	ICD-9 code examples
1	Time limited: minor	558.9 Noninfectious gastroenteritis and colitis 373.2 Chalazion
2	Time limited: minor-primary infections	490 Bronchitis 462 Acute pharyngitis
3	Time limited: major	451.2 Phlebitis of lower extremities 633.9 Unspecified ectopic pregnancy
4	Time limited: major-primary infections	711.0 Pyogenic arthritis 573.3 Hepatitis, unspecified
5	Allergies	477.9 Allergic rhinitis, cause unspecified 708.9 Unspecified urticaria
6	Asthma	493.0 Extrinsic asthma 493.1 Intrinsic asthma
7	Likely to recur: discrete	381.1 Chronic serous otitis media 616.1 Vaginitis and vulvovaginitis
8	Likely to recur: discrete-infections	599.0 Urinary tract infection 131.0 Urogenital trichomoniasis
9	Likely to recur: progressive	434.0 Cerebral thrombosis 577.0 Acute pancreatitis
10	Chronic medical: stable	401.9 Essential hypertension 278.0 Obesity
11	Chronic medical: unstable	282.6 Sickle cell anemia 428.0 Congestive hearth failure
12	Chronic speciality: stable-orthopedic	721.0 Cervical spondylosis without myelopathy 735.4 Hammer toe
13	Chronic speciality: stable-ear nose, throat	389.9 Unspecified hearing loss 385.3 Cholesteatoma
14	Chronic speciality: stable-eye	372.9 Unspecified disorder of conjonctiva 367.0 Hypermetropia
15	Chronic speciality: stable-other	256.4 Polycystic ovaries V45.0 Postsurgical cardiac pacemaker in situ
16	Chronic speciality: unstable-orthopedic	726.0 Adhesive capsulitis of the shoulder 722.2 Displacement of intervertebral disk
17	Chronic speciality: unstable-ear nose, throat	383.1 Chronic mastoiditis 386.0 Meniere's disease

18	Chronic speciality: unstable-eye	365.9 Unspecified glaucoma 379.0 Scleritis
19	Chronic speciality: unstable-other	617.9 Endometriosis, site unspecified 348.2 Benign intracranial hypertension
20	Dermatologic	704.0 Alopecia 448.1 Naevus, non-neoplastic
21	Injuries/adverse effects: minor	920 Contusion of face, scalp, and neck 847.0 Neck sprain
22	Injuries/adverse effects: major	854.0 Intracranial injury 807.0 Closed fracture of rib(s)
23	Psychosocial: time limited-minor	309.0 Brief depressive reaction 310.2 Postconcussion syndrome
24	Psychosocial: recurrent or persistent, stable	317 Mild mental retardation 799.2 Nervousness
25	Psychosocial: recurrent or persistent, unstable	291 Alcoholic psychoses 295 Schizophrenic disorders
26	Signs/Symptoms:minor	784.0 Headache 787.0 Nausea and vomiting
27	Signs/Symptoms:uncertain	716.9 Unspecified arthropathy 786.6 Swelling, mass or lump in chest
28	Signs/Symptoms:minor	429.3 Cardiomegaly 780.2 Syncope and collapse
29	Discretionary	550.9 Inguinal hernia 706.2 Sebaceous cyst
30	See and reassure	611.1 Hypertrophy of breast 562.1 Diverticula of colon
31	Prevention/Administrative	V20.2 Routine infant or child health check V72.3 Gynecological examination
32	Malignancy	174.9 Malignant neoplasm of breast (female) 201.9 Hodgkin's disease, unspecified type
33	Pregnancy	V22.2 Pregnant state 650 Delivery in a completely normal case
34	Dental	521.0 Dental caries 523.1 Chronic gingivitis

APPENDIX 3

Detailed regression model for the principal outcome:

dependant variable: Number of medical consultations per patient in the 3 months following index date.

Adjusted R-square = 0.138

Variable	beta	pvalue
Principal independant variable:		
speciality (0=subspeciality 1=GIM)	0.141	0.005
Setting variables		
Outpatient	reference	
Emergency room	0.340	0.0001
Em. room*speciality interac.	0.172	0.0001
Acute care hospital	0.421	0.0001
ICU / CCU	0.942	0.0001
ICU / CCU*speciality interac.	-0.163	0.003
Age variables		
Young category	-0.222	0.0001
Young cat. residual variation	0.006	0.0001
Young * speciality interact.	0.116	0.003
Middle category	reference	
Middle cat. residual variation	0.016	0.004
Old category	-0.007	0.78
Old * speciality interaction	-0.164	0.0002
Net education level	0.340	0.0001
Patient gender	-0.043	0.002
Physician gender	0.103	0.0001
Distance variables		
Urban	reference	
intermediate	-0.160	0.0001
Interm*speciality interaction	-0.217	0.0001
Remote	-0.316	0.0001
Remote* speciality interac.	-0.268	0.0001
Charlson comorbidity index (baseline period)	0.051	0.0001
PPSU variables (baseline period)		
No acute hospital visits	0.013	0.003
No emerg. room visits	0.008	0.0001
No of different physicians	0.021	0.0001
No of visits to physicians	-0.006	0.0001
No of visits to specialists	0.009	0.0001

Variable	beta	pvalue
ADG categories		
ADG 1	-0.032	0.07
ADG 2	-0.030	0.08
ADG 3	-0.023	0.19
ADG 4	0.050	0.02
ADG 5	-0.027	0.55
ADG 6	-0.014	0.62
ADG 7	-0.027	0.12
ADG 8	-0.028	0.24
ADG 9	-0.036	0.12
ADG 10	0.010	0.49
ADG 11	0.093	0.0001
ADG 12	-0.061	0.13
ADG 13	-0.074	0.08
ADG 14	-0.010	0.76
ADG 15	0.268	0.17
ADG 16	-0.012	0.88
ADG 17	-0.120	0.006
ADG 18	-0.015	0.54
ADG 19	-0.050	0.56
ADG 20	0.036	0.25
ADG 21	-0.073	0.0007
ADG 22	-0.116	0.0001
ADG 23	0.009	0.84
ADG 24	-0.036	0.10
ADG 25	-0.206	0.0001
ADG 26	-0.017	0.34
ADG 27	-0.004	0.83
ADG 28	-0.024	0.12
ADG 29	-0.057	0.004
ADG 30	-0.054	0.23
ADG 31	-0.048	0.003
ADG 32	-0.074	0.02
ADG 33	-0.149	0.01
ADG 34	-0.001	0.99
Physician year of graduation variables		
Before 1960	reference	
From 1960 to 69	0.054	0.06
From 1970 to 79	0.037	0.16
From 1980 to 88	0.027	0.0003
After 1988	-0.122	0.18

Multiple partial tests

PPSU: p = 0.0001 Physician year of graduation: p = 0.0001 ADG groups: p = 0.0001

APPENDIX 4

Detailed regression model for total consultations:

dependant variable: Total number of consultations per patient in the 3 months following index date.

Adjusted R-square = 0.130

Variable	beta	pvalue	Variable	beta	pvalue
Principal independant variable:			ADG categories		
speciality (0=subspeciality	0.245	0.0002	ADG 1	-0.036	0.11
1=GIM)			ADG 2	-0.063	0.005
Setting variables			ADG 3	-0.009	0.69
Outpatient	reference		ADG 4	0.045	0.11
Emergency room	0.437	0.0001	ADG 5	-0.092	0.12
Em. room*speciality interac.	0.191	0.0001	ADG 6	-0.077	0.04
Acute care hospital	0.622	0.0001	ADG 7	-0.011	0.62
ICU / CCU	1.098	0.0001	ADG 8	-0.009	0.77
ICU / CCU*speciality interac.	-0.203	0.005	ADG 9	-0.107	0.0005
			ADG 10	0.016	0.43
Age variables			ADG 11	0.028	0.19
Young category	-0.282	0.0001	ADG 12	-0.042	0.42
Young cat. residual variation	0.008	0.0001	ADG 13	-0.040	0.47
Young * speciality interact.	0.152	0.003	ADG 14	-0.055	0.20
Middle category	reference		ADG 15	0.369	0.01
Middle cat. residual variation	0.020	0.006	ADG 16	0.080	0.45
Old category	-0.013	0.69	ADG 17	-0.111	0.05
Old * speciality interaction	-0.202	0.0005	ADG 18	-0.007	0.82
			ADG 19	-0.110	0.34
Net education level	0.363	0.0001	ADG 20	0.020	0.62
			ADG 21	-0.070	0.01
Patient gender	-0.040	0.03	ADG 22	-0.116	0.0001
			ADG 23	0.047	0.41
Physician gender	0.122	0.0003	ADG 24	0.038	0.18
			ADG 25	-0.069	0.13
Distance variables			ADG 26	0.001	0.97
Urban	reference		ADG 27	-0.018	0.52
intermediate	-0.185	0.0001	ADG 28	-0.052	0.009
Interm*speciality interaction	-0.270	0.0001	ADG 29	-0.093	0.0004
Remote	-0.345	0.0001	ADG 30	-0.025	0.67
Remote* speciality interac.	-0.362	0.0001	ADG 31	-0.065	0.003
			ADG 32	-0.036	0.40
Charlson comorbidity index	0.056	0.0001	ADG 33	-0.051	0.51
(baseline period)			ADG 34	-0.009	0.95
PPSU variables (baseline period)			Physician year of graduation variables		
No acute hospital visits	0.016	0.006	Before 1960	reference	
No emerg. room visits	0.010	0.0002	From 1960 to 69	0.064	0.09
No of different physicians	0.031	0.0001	From 1970 to 79	0.055	0.11
No of visits to physicians	-0.007	0.0001	From 1980 to 88	0.134	0.0002
No of visits to specialists	0.011	0.0001	After 1988	-0.045	0.70

Multiple partial tests

PPSU: p = 0.0001   Physician year of graduation: p = 0.0001   ADG groups: p = 0.0001

APPENDIX 5

Detailed regression model for usual provider continuity:

dependant variable: Proportion of all visits per patient, made to the most prevalent physician in the 3 months following index date.

Adjusted R-square = 0.104

Variable	beta	pvalue	Variable	beta	pvalue
Principal independant variable:			ADG categories		
speciality (0=subspeciality	-0.007	0.0002	ADG 1	-0.006	0.01
1=GIM)			ADG 2	-0.004	0.12
Setting variables			ADG 3	0.001	0.78
Outpatient	reference		ADG 4	0.000	0.98
Emergency room	-0.087	0.0001	ADG 5	-0.005	0.39
Em. room*speciality interac.	0.019	0.003	ADG 6	-0.007	0.09
Acute care hospital	-0.078	0.0001	ADG 7	-0.003	0.27
Ac. care*speciality interaction	0.035	0.0001	ADG 8	0.001	0.82
ICU / CCU	-0.111	0.0001	ADG 9	-0.001	0.75
ICU / CCU*speciality interac.	0.052	0.0001	ADG 10	-0.009	0.0001
			ADG 11	-0.020	0.0001
Age variables			ADG 12	0.011	0.06
Young category	0.015	0.0001	ADG 13	-0.000	0.95
Young cat. residual variation	-0.001	0.0001	ADG 14	-0.004	0.37
Young * speciality interact.	-0.018	0.001	ADG 15	-0.007	0.64
Middle category	reference		ADG 16	-0.012	0.29
Old category	0.008	0.01	ADG 17	-0.001	0.83
Old * speciality interaction	0.018	0.004	ADG 18	-0.017	0.0001
			ADG 19	-0.022	0.08
Net education level	-0.031	0.0001	ADG 20	-0.003	0.52
			ADG 21	0.004	0.14
Distance variables			ADG 22	0.004	0.23
Urban	reference		ADG 23	-0.011	0.09
intermediate	0.002	0.55	ADG 24	-0.011	0.0007
Interm*speciality interaction	0.020	0.001	ADG 25	0.008	0.08
Remote	0.030	0.0001	ADG 26	-0.003	0.19
			ADG 27	-0.004	0.24
PPSU variables (baseline period)			ADG 28	-0.001	0.75
No acute hospital visits	0.002	0.009	ADG 29	0.002	0.51
No of different physicians	-0.004	0.0001	ADG 30	0.016	0.02
No of visits to physicians	0.0003	0.0001	ADG 31	0.005	0.03
			ADG 32	-0.010	0.006
Physician year of graduation variables			ADG 33	-0.002	0.81
Before 1960	reference		ADG 34	0.030	0.05
From 1960 to 69	-0.012	0.002			
From 1970 to 79	-0.021	0.0001			
From 1980 to 88	-0.025	0.0001			
After 1988	-0.019	0.14			

Multiple partial tests

PPSU: p = 0.0001 Physician year of graduation: p = 0.0001 ADG groups: p = 0.0001

APPENDIX 6

Detailed regression model for the number of different physicians:

dependant variable: Total number of different physicians visited in the 3 months following index date.

Adjusted R-square = 0.220

Variable	beta	pvalue	Variable	beta	pvalue
Principal independant variable:			ADG categories		
speciality (0=subspeciality 1=GIM)	0.455	0.002	ADG 1	-0.169	0.004
			ADG 2	-0.135	0.02
Setting variables			ADG 3	-0.062	0.30
Outpatient	reference		ADG 4	-0.029	0.69
Emergency room	1.926	0.0001	ADG 5	-0.089	0.56
Acute care hospital	2.566	0.0001	ADG 6	0.025	0.80
Ac.care*speciality interaction	-0.539	0.0001	ADG 7	-0.118	0.04
ICU / CCU	4.009	0.0001	ADG 8	-0.095	0.24
ICU / CCU*speciality interac.	-0.959	0.0001	ADG 9	-0.076	0.32
			ADG 10	0.039	0.44
Age variables			ADG 11	0.340	0.0001
Young category	-1.068	0.0001	ADG 12	-0.110	0.42
Young cat. residual variation	0.026	0.0001	ADG 13	-0.065	0.64
Young * speciality interact.	0.509	0.0001	ADG 14	-0.230	0.03
Middle category	reference		ADG 15	0.442	0.23
Old category	-0.347	0.0001	ADG 16	0.162	0.55
			ADG 17	-0.247	0.10
Net education level	0.824	0.0001	ADG 18	0.219	0.006
			ADG 19	-0.228	0.44
Patient gender	-0.172	0.0003	ADG 20	0.007	0.94
			ADG 21	-0.261	0.0003
Distance variables			ADG 22	-0.327	0.0001
Urban	reference		ADG 23	0.172	0.25
intermediate	-0.302	0.0001	ADG 24	0.209	0.004
Interm*speciality interaction	-0.853	0.0001	ADG 25	-0.146	0.21
Remote	-0.986	0.0001	ADG 26	-0.063	0.30
Remote* speciality interac.	-0.763	0.0001	ADG 27	-0.038	0.59
			ADG 28	-0.192	0.0002
PPSU variables (baseline period)			ADG 29	-0.185	0.006
No emerg. room visits	0.043	0.0001	ADG 30	-0.216	0.16
No of different physicians	0.133	0.0001	ADG 31	-0.287	0.0001
No of visits to specialists	0.004	0.002	ADG 32	0.278	0.002
			ADG 33	-0.043	0.83
Physician year of graduation variables			ADG 34	0.082	0.82
Before 1960	reference				
From 1960 to 69	0.316	0.001			
From 1970 to 79	0.417	0.0001			
From 1980 to 88	0.693	0.0001			
After 1988	0.358	0.24			

Multiple partial tests

PPSU: p = 0.0001 Physician year of graduation: p = 0.0001 ADG groups: p = 0.0001

APPENDIX 7

Detailed regression model for index consultant charges:

dependant variable: Charges billed directly or on the request of the index consultant in the 3 months following index date.

Adjusted R-square = 0.131

Variable	beta	pvalue
Principal independant variable:		
speciality (0=subspeciality 1=GIM)	41.42	0.0001
Setting variables		
Outpatient	reference	
Emergency room	10.70	0.0001
Acute care hospital	82.70	0.0001
Acute care*speciality interac.	17.93	0.0001
ICU / CCU	208.08	0.0001
Age variables		
Young category	-8.22	0.003
Young cat. residual variation	0.94	0.0001
Middle category	reference	
Old category	-26.13	0.0001
Average family income	-0.001	0.0001
Distance variables		
Urban	reference	
intermediate	-6.52	0.03
Interm*speciality interaction	-42.10	0.0001
Remote	-17.25	0.0001
Remote*speciality interac.	-75.29	0.0001
PPSU variables (baseline period)		
No acute hospital visits	-2.96	0.0001
No admission to ICU/CCU	-4.86	0.004
No of visit to physician	-0.24	0.005
No of visits to specialist	0.68	0.0001
Physician year of graduation variables		
Before 1960	reference	
From 1960 to 69	8.15	0.04
From 1970 to 79	14.46	0.0001
From 1980 to 88	1.90	0.60
After 1988	-13.82	0.27

Variable	beta	pvalue
ADG categories		
ADG 1	-1.84	0.43
ADG 2	-2.11	0.37
ADG 3	-0.92	0.71
ADG 4	4.36	0.14
ADG 5	-2.05	0.74
ADG 6	1.68	0.67
ADG 7	2.67	0.26
ADG 8	-1.59	0.62
ADG 9	-5.66	0.08
ADG 10	-1.58	0.44
ADG 11	-8.66	0.0001
ADG 12	2.06	0.70
ADG 13	-6.44	0.26
ADG 14	-9.32	0.04
ADG 15	2.53	0.86
ADG 16	5.36	0.63
ADG 17	4.39	0.46
ADG 18	0.04	0.99
ADG 19	-4.90	0.68
ADG 20	-2.95	0.49
ADG 21	-3.27	0.26
ADG 22	-5.39	0.06
ADG 23	2.33	0.70
ADG 24	-7.38	0.01
ADG 25	-16.10	0.0007
ADG 26	-2.69	0.27
ADG 27	-1.15	0.68
ADG 28	-8.52	0.0001
ADG 29	-1.34	0.62
ADG 30	-5.88	0.35
ADG 31	2.79	0.21
ADG 32	4.38	0.24
ADG 33	9.80	0.22
ADG 34	11.40	0.43

Multiple partial tests

PPSU: p = 0.0001 Physician year of graduation: p = 0.0001 ADG groups: p = 0.0001

APPENDIX 8

Detailed regression model for total charges:

dependant variable: Total charges billed by any physician in the 3 months following index date.

Adjusted R-square = 0.144

Variable	beta	pvalue	Variable	beta	pvalue
Principal independant variable:			ADG categories		
speciality (0=subspeciality	121.42	0.0001	ADG 1	-31.19	0.01
1=GIM)			ADG 2	-28.77	0.02
Setting variables			ADG 3	10.11	0.43
Outpatient	reference		ADG 4	21.01	0.17
Emergency room	228.21	0.0001	ADG 5	-14.96	0.64
Acute care hospital	474.59	0.0001	ADG 6	-27.15	0.19
ICU / CCU	945.16	0.0001	ADG 7	-39.03	0.002
ICU / CCU*speciality interac.	-175.87	0.0001	ADG 8	-19.53	0.25
			ADG 9	-0.34	0.98
Age variables			ADG 10	16.35	0.13
Young category	-168.94	0.0001	ADG 11	55.97	0.0001
Young cat. residual variation	5.86	0.0001	ADG 12	-36.82	0.20
Middle category	reference		ADG 13	3.30	0.91
Old category	-85.30	0.0001	ADG 14	-39.82	0.09
			ADG 15	95.92	0.23
Net education level	165.43	0.0001	ADG 16	147.28	0.01
			ADG 17	-40.10	0.21
Average family income	-0.004	0.009	ADG 18	29.29	0.09
			ADG 19	-59.49	0.34
Distance variables			ADG 20	-20.24	0.37
Urban	reference		ADG 21	-21.33	0.16
intermediate	-9.53	0.60	ADG 22	-49.26	0.001
Interm*speciality interaction	-150.99	0.0001	ADG 23	19.16	0.54
Remote	-12.25	0.51	ADG 24	21.85	0.16
Remote*speciality interac.	-203.85	0.0001	ADG 25	-54.48	0.03
			ADG 26	-17.98	0.17
Charlson comorbidity index	17.65	0.0002	ADG 27	-17.28	0.25
(baseline period)			ADG 28	-23.83	0.03
			ADG 29	-37.98	0.008
PPSU variables (baseline period)			ADG 30	-15.58	0.64
No acute hospital visits	12.33	0.0001	ADG 31	-35.13	0.003
No of different physicians	4.47	0.0002	ADG 32	47.35	0.04
No of visits to specialist	3.02	0.0001	ADG 33	137.29	0.001
			ADG 34	-9.03	0.90
Physician year of graduation variables					
Before 1960	reference				
From 1960 to 69	64.12	0.002			
From 1970 to 79	70.13	0.0002			
From 1980 to 88	109.07	0.0001			
After 1988	68.95	0.29			

Multiple partial tests

PPSU: p = 0.0001 Physician year of graduation: p = 0.0001 ADG groups: p = 0.0001

References:

1-Greenfield S. Dividing up the turf. Generalists versus specialists. (editorial) J Gen Intern Med 1996; 11:245-6.

2-Neilson EG. When does a generalist need a specialist? J Gen Intern Med 1996; 11:247-8.

3-Braunwald E. Subspecialists and internal medicine: A perspective. Annals of Internal Medicine. 1991:114:76-78.

4-Petersdorf RG. The doctor is in. Academic Medicine.1993.68(2):113-117.

5-Goldstein S. Stabilizing the care of unstable angina (Editorial). J Am Coll Cardiol 1995;26:583-84.

6-Kassirer JP. Access to speciality care. N Engl J Med 1994;331:1151-1153.

7-Groupe d'étude sur la planification des effectifs médicaux de la Société canadienne de médecine interne. Médecine interne générale. Une ressource précieuse pour le système de soins de santé du Canada. Un document de discussion. Société canadienne de médecine interne, août 1995.

8-AIRGQ. Pour la survie de la médecine interne au Québec. 2 septembre 1992.

9-Donabedian A. The quality of care. How can it be assessed? JAMA 1988;260:1743-1748.

10-Wennberg J. Which rate is right? (Editorial). N Engl J Med 1986;314:310-311.

11-Fihn SD. Physician speciality, systems of health care, and patient outcomes. JAMA 1995;274:1473-1474.

12-Agency for health care policy and research. Primary care and health care reform (grant announcement). Rockville MD, june 1993.

13-Brook RH, Mcglynn EA, Cleary PD. Quality of care part 2: Measuring quality of care. N Engl J Med 1996;335:966-970.

14- Angell M, JP. Quality and the medical marketplace - Following elephants. N Eng J Med 1996;335:883-885.

15-Royal College of Physicians and Surgeons of canada. September 1983 Council. Position paper on primary care. Annals RSCPC. 1984.17(6);467-471.

16-Cook DJ, Sackett DL. Roles of the canadian general internist. Annals RSCPC;28:1-3.

17-Contandriopoulos AP, Fournier MA, Champagne F, Denis JL. Les médecins internistes et la pratique de deuxième ligne au Québec. Groupe de Recherche Interdisciplinaire en Santé, Facultée de médecine, Université de Montréal. Août 1995.

18-Robinson A. Forging a new subspeciality: general internal medicine. Can Med Assoc J 1994:150(2):1995-1998.

19-Lambrew JM, DeFriese GH, Carey TS, Ricketts TC, Biddle AK. The effects of having a regular doctor on access to primary care. Med Care 1996;34:138-15.

20-Hillman AL. HMO, financial incentives, and physicians' judgments. Ann Intern Med 1990;112:891-893.

21- Noble J. General internal medicine in internal medicine: at the core or on the periphery? Ann Intern Med 1992;116:1058-1060.

22-Pineo GF, MacKinnon B, Sackett D. Assessment of manpower needs in internal medicine: results of the Canadian Society of Internal Medicine questionnaire. Unpublished. 1986.

23- Collège Royal des Médecins et Chirurgiens du Canada et Collège des Médecins de Famille du Canada. Relation entre le médecin de famille et le spécialiste consultant dans la prestation des soins de santé. Rapport du groupe de travail,1993.

24- Quality of health care. part 1: quality of care - what is it? Blumenthal D. N Eng J Med 1996;335:891-895.

25- Donabedian A. Exploration in quality assessment and monitoring. Vol 1. The definition of quality and approaches to its assessment. Ann Arbor, Mich.: Health administration press, 1980.

26- American Medical Association, Council of Medical Service. Quality of care. JAMA 1986;256:1032-1034.

27-Brook RH, Mcglynn EA, Cleary PD. Quality of care part 2: Measuring quality of care. N Engl J Med 1996;335:966-970.

28-Hammermeister KE,Shroyer AL, Sethi GK, Grover FL. Why it is important to demonstrate linkages between outcomes of care and processes and structures of care. Med Care 1995; 33:OS5-OS16.

29- Décret No 427-94 du gouvernement du Québec. 23 mars 94

30- Conseil Médical du Québec. Avis sur une nouvelle dynamique organisationnelle à implanter: la hiérarchisation des services médicaux. 1995

31-Conférence des Doyens des Facultés de médecine du Québec. L'engagement des facultés de médecine envers les régions du Québec. mai1991.

32-Gouvernement du Québec. Politique triennale des inscriptions dans les programmes de formation doctorale et postdoctorale en médecine pour 1992-1993, 1993-1994 et 1994-1995. 1992

33-Lauzon C, Dupuis R, Davis R, Talajic M, Stewart D, Warnica W, Gardner M, Sussex B, Savard P, Mikes E, Rouleau JL, Ferguson J. Comparative survival and management of acute myocardial infarction between a regional and tertiary care centers. Oral presentation and abstract, 67th scientific session, American Hearth Association, november 1994.

34-Manu P, Schwartz SE. Patterns of diagnostic testing in the academic setting: the influence of medical attendings' subspeciality training. Soc Sci Med 1983;17:1339-1342.

35-Mendenhall RC, Moynihan CJ, Radecki SE. The relative complexity of primary care provided by medical subspecialists. Med Care 1984;22:987-1001.

36-Greenwald HP,Peterson ML,Garrison LP, Hart G, Moscovice IS, Hall TL, Perrin EB. Interspeciality variation in office-based care. Med Care 1984;22:14-29.

37-Greenfield S, Nelson EC, Zubkoff M, Manning W, Rogers W, Kravitz RL, Keller A, Tarlov AR, Ware JE. Variations in Ressource Utilization Among Medical specialities and Systems of Care. JAMA. 1992;267:1624-1630.

38-Greenfield S, Rogers W, Mangotich M, Carney MF, Tarlov AR. Outcomes of patients with hypertension and non-insulin-dependent diabetes mellitus treated by different systems and specialities. JAMA 1995;274:1536-1444.

39-Strauss MJ, Conrad D, LoGerfo JP, Hudson LD, Bergner M. Cost and outcome of care for patients with chronic obstructive lung disease. Analysis by physician speciality. Med Care 1986;24:915-924.

40-Bernard AM, Shapiro LR, McMahon LF. The influence of attending physician subspecialization on hospital length of stay. Med Care 1990;28:170-174.

41-Levetan CS, Salas JR, Wilets IF, Zumoff B. Impact of Endocrine and Diabetes Team Consultation on Hospital Length of Stay for Patients With Diabetes. Am J Med.1995:99;22-28.

42-Cleary PD, Greenfield S,Mulley AG, Pauker SG, Schroeder SA,Wexler L, NcNeil BJ. Variations in length of stay and outcomes for six medical and surgical conditions in Massachusetts and California. JAMA 1991;266:73-79.

43-Hnatiuk O, Moores L, Loughney T, Torrington K. Evaluation of internists' spirometric interpretations.J Gen Intern Med 1996;11:204-208.

44-Schreiber TL, Elkhatib A,Grines CL, O'neill WW. Cardiologist Versus Internist Management of Patient With Unstable Angina: Treatment Pattern and Outcome. J Am Coll Cardiol 1995;26:577-82.

45-Ayanian JZ, Haupman PJ, Guadagnoli E, Antman EM, Pashos CL, Mcneil BJ. Knowledge and practices of generalist and specialist physicians regarding drug therapy for acute myocardial infarction. N Engl J Med 1994;331:1136-1142.

46-Kassirer JP. Our stubborn quest for diagnostic certainty. N Engl J Med. 1989;320:1489-91.

47-Mold JW,Stein HF. The cascade effect in the clinical care of the patients. N Engl J Med 1986;314:512-514.

48-Berenson R, Holahan J. Sources of the growth in medicare physician expenditures. JAMA 1992;267:687-691.

49-Fletcher RH, Fletcher SW. Internal medicine: whole or in piece? Ann Intern Med 1991;115:978-979.

50-Hartley RM, Charlton JR, Harris CM, Jarman B. Patterns of physicians' use of medical ressouces in ambulatory settings. Am J Public Health 1987;77:565-567.

51-Grol R, Whitfield M, De Maeseneer J, Mokkink H. Attitudes to risk taking in medical decision making among British, Dutch and Belgian general practitioners. Br J Gen Pract 1990;40:134-136.

52-Neil S. Calman MD; Ruth Bernstein Hyman, PhD; and Warren Licht, MD. Variability in consultation rates and practitioner level of diagnostic certainty. J Fam Pract 1992; 35:31-38.

53- Madeley RJ, Evans JR, Muir B. The use of routine referral data in the development of clinical audit and management in North Lincolnshire. J Pub Health Med 1990; 12:22-27.

54-Kravitz RL, Greenfield S, Rogers W, Manning W, Zubkoff M, Nelson EC, Tarlov AR, Ware JE. Differences in the mix of patients among medical specialities and among systems of care: results from the Medical Outcome Study. JAMA. 1992; 267:1617-1623.

55-Reynolds GA, Chitnis JG, Roland M. General practitioner outpatient referrals: do good doctors refer more patients to hospital? BMJ.1991;302:1250-52.

56-Wilkin D, Smith AG. Variation in general practitioners' referral rates to consultants. J Royal Coll Gen Pract 1987;37:350-353.
57-Geyman JP, Brown TC, Rivers K. Referrals in family practice: A comparative study by geographic region and practice setting. J Fam Pract 1976;3:163-167.
58-Roland MO, Bartholomew J, Morrell DC, McDermott A, Paul E.Understanding hospital referral rates: a user's guide. Br Med J 1990;301;98-102.
59-Anonymous. Bermingham research unit. Practice activity analysis. 5. Referrals to specialists. J Roy Coll Gen Pract 1978;28:251-252.
60-Shortell SM, Vahovich SG. Patient referral differences among specialities. Health Serv Res 1975;10:146-161.
61-Schmidt DD. Referral patterns in an individual family practice. J Fam Pract 1977;5:401-403.
62-Cummins RO, Jarman B, White PM. Do general practitioners have different referral Threshold? BMJ 1981;282:1037-39.
63-Coulter A, Noone A, Goldacre M. General practitioners' referrals to specialist outpatient clinics. 1. Why general practitioners refer patients to outpatient clinics. BMJ 1989;299:304-8.
64-Zvieli S, Steinherz R. Reason for referrals among military primary care physicians. Military Med 1992;57:420-423.
65-Muzzin LJ. Understanding the process of medical referral. Part1: Critique of the literature. Can Fam Physician 1991;37:2155-2161.
66-Ludke RL. An examination of the factors that influence patient referral decision. Med Care 1982;20:182-196.
67-Langley GR, MacLellan AM, Sutherland HJ, Till JE. Effect of nonmedical factors on family physicians' decisions about referral for consultation. Can Med Assoc J 1991.
68-Armstrong D, Fry J, Armstrong P. Doctors' perceptions of pressure from patients for referral. Br Med J 1991;302:1186-1188.
69-Tamblyn R, Abrahamowicz, Brailovsky C, Grand'Maison P, Lescop J, Norcini J, Girard N, Haggerty J. The association between licensing examination scores and medical practice. Clinical Epidemiology division, McGill University, 1996.
70-Holtgrave DR, Lawler F, Spann SJ. Physicians' risk attitudes, laboratory usage, and referral decisions: The case of an academic family practice center. Med Decis Making 1991;11:125-130.
71-Surender R,Bradlow J,Coulter A, Doll H,Brown SS. Prospective study of trends in referral patterns fundholding and non-funholding practices in the Oxford region, 1990-4. BMJ 1995;311:1205-1208.
72-Coulter A, Bradlow J. Effect of NHS reforms on general practitioners' referral patterns. Br Med J 1993;306:433-437.
73-Mayer TR. Family practice referral patterns in a health maintenance organization.J Fam Pract 1982;14:315-319.
74-Muzzin LJ. Understanding the process of medical referral. Part4: Accessibility of consultants. Can Fam Physician 1992;38:77-82.

75-Noone A, Goldacre M, Coulter A, Seagroatt V. Do referral rates vary widely between practices and does supply of services affect demand? A study in Milton Keynes and the Oxford region.J R Coll Gen Pract 1989;39:404-407.

76-Muzzin LJ. Understanding the process of medical referral. Part2:Methodology of the study. Can Fam Physician 1991;37:2377-2382.

77-Moore AT, Roland MO. How much variation in referral rates among general practitioners is due to chance. Br Med J 1989;298:500-502.

78- Lee T, Pappius EM, Goldman L. Impact of inter-physician communication on the effectiveness of medical consultations. Am J Med 1983;74:106-112.

79-Nutting PA, Franks P, Clancy C. Referral and consultation in primary care: do we understand what we're doing? (editorial) J Fam Pract. 1992;35:21-23.

80-Knottnerus JA, Joosten J, Daams J. Comparing the quality of referrals of general practitioners with high and average referral rates: an independent panel review. Br J Gen Pract 1990;40:178-181.

81-Coulter A, Seagroatt V, McPherson K. Relation between general practices' outpatient referral rates and rates of elctive admission to hospital. Br Med J 1990;301:273-276.

82-Wilkin D, Metcalfe DH, Marinker M. The meaning of information on GP referral rates to hospitals.Comm Med 1989;11:65-70.

83-Franks P, Clancy CM, Nutting PA. Gatekeeping revisited - protecting patients from overtreatment. N Engl J Med 1992;327:424-429.

84-Campion EW. Continuity counts. JAMA 1984;252:2459.

85-Fletcher RH, Fletcher SW. What is the future of internal medicine? Ann Intern Med 1993;119:1144-1145.

86-Roos LL, Roos NP, Gilbert P, Nicol JP. Continuity of care: does it contribute to quality of care? Medical care 1980;18(2):174-184.

87-Becker MH, Drachman RH, Kirscht JP. A field experiment to evaluate various outcomes of continuity of physician care. Am J Public Health 1974;64:1062-1070.

88-Bice TW, Boxerman SB. A quantitative measure of continuity of care. Medical care 1977; 15:347-349.

89-Safran DG, Tarlov AR, Rogers WH. Primary care performance in fee-for-service and prepaid health care system. Results from the medical outcomes study. JAMA 1994;271;1579-1586.

90-Wasson JH, Sauvigne AE, Mogielnicki RP, frey WG,Sox CH, Gaudette C, Rockwell A. Continuity of outpatient care in elderly men. A randomized trial. JAMA 1984;252:2413-2417.

91-Dietrich AJ, Nelson EC, Kirk JW, Zubkoff M, O'Connor GT. Do primary care physicians actually manage their patients' fee-for-service care? JAMA 1988;259:3145-3149.

92-Fletcher RH, O'Malley MS, Fletcher SW, Earp JL, Alexander JP. Measuring the continuity and coordination of medical care in a system involving multiple providers. Med Care 1984;22:403-411.

93-Lofgren RP, Gottlieb D, Williams RA, Rich EC. Post-call transfer of resident responsibility: its effect on patient care. J Gen Intern Med 1990;5:501-505.

94-Starfield BH, Simborg DW, Horn SD, Yourtee SA. Continuity and coordination in primary care: their achievement and utility. Med Care 1976;14:625-636.
95-Dietrich AJ, Marton KI. Does continuous care from a physician make a difference. J Fam Pract 1982;15:929-937.
96-Hayward RA, Bernard AM, Freeman HE, Corey CR. Regular source of ambulatory care ans access to health services. Am J Pub Health 1991;81:434-438.
97- Col N, Fanale JE, Kronholm P. The role of medication noncompliance and advers drug reactions in hospitalisations of the elderly. Arch Intern Med 1990;150:841-845.
98-Tamblyn RM, McLeod PJ, Abrahamowicz M, Laprise R. Do too many cooks spoil the broth? Multiple physician involvement in medical management of elderly patients and potentially innappropriate drug combinations. Can Med Assoc J 1996;154(8):1177-1184.
99-Schneeweiss R, Ellsbury K, Hart LG, Geyman JP. he Economic Impact and Multiplier Effect of a Family Practice Clinic on an Academic Medical Center. JAMA 1989;262:370-5.
100-Glenn JK, Lawler FH,Hoerl MS. Physician referrals in a competitive environment. An Estimate of the economic impact of referral. JAMA 1987;258:1920-1923.
101-Kues JR, Sacks JG, Davis LJ,Smith R. The value of a new family practice center patient to the academic medical center. J Fam Pract 1991;32:571-575.
102-Collège des Médecins du Québec. Avis du Service des études médicales sur le Sous-comité sur la reconnaissance et l'évolution des spécialités (SCRES). Novembre 1995.
*103-Service des communications de la Régie de l'assurance-maladie du Québec. Statistiques annuelles 1990. Québec, 1990.
104- Tamblyn R et al. The feasibility of using standardized patients to measure the medical management of high risk prescribing situations in the elderly. Final report. NHRDP project #6605-3752-57P.
105- Edward N, Wilkins R, Perras A. À quelle distance se trouve le plus proche hôpital? Le calcul des distances à l'aide du fichier de conversion des codes postaux de Statistique Canada. Rapports sur la santé 1993; vol 5:179-88.
106- Ramsay C, Walker M. Waiting your turn: Hospital waiting lists in Canada (5th edition). Fraser Forum supplement. Fraser institute.
107-Roos NP, Mustard CA. Variation in health and health care use by socio-economic status in Winnipeg,Canada: The system works well? Yes and no. Unpublished. Department of Community Health Sciences. University of Manitoba,1996.
108- Blishen RB, Carroll WK, Moore C. The 1981 socioeconomic index for occupations in Canada. Canad Rev Soc & Anth:.1987:24;466-88.
109- Demissie K, Hanley JA, Menzies D, Joseph L, Ernst P. Agreement in measuring socioeconomic status: area based versus individual measures. Respiratory Epidemiology Unit, Department of epidemiology and biostatistics, McGill University, Canada.
110-Green J, Wintfeld N, Passman LJ. The importance of severity of illness in assessing hospital mortality. JAMA 1990;263:241-246.
111-Greenfield S, Aronow HU, Elashoff RM, Watanabe D. Flaws in mortality data. The hazards of

ignoring comorbid disease. JAMA 1988;266:2253-2255.

112-Roos LL, Sharp SM, Cohen MM, Wajda A. Risk adjustment in claim-based research: the search for efficient approaches. J Clin Epidemiol 1989;42:1193-1206.

113-Weiner JP, Starfield BH, Steinwachs DM, Mumford LM. Development and application of a population oriented measure of ambulatory care case mix. Med Care 1991;29:452-472.

114-Schwartz M, Iezzoni LI, Moskowitz MA, Ash AS,Sawitz E. The importance of comorbidities in explaining differences in patient costs. Med Care 1996;34:767-782.

115-Matsui K, Goldman L, Johnson PA, Kuntz KM, Cook EF, Lee TH. Comorbidity as a correlate of length of stay for hospitalized patients with acute chest pain. J Gen Intern Med 1996;11:262-268.

116-Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chron Dis 1987;40;373-383.

117-Krousel-Wood MA, Abdoh A,Re R. Comparing comorbid-illness indices assessing outcome variation: the case of prostatectomy. J Gen Intern Med 1996;11:32-38

118- Association des Internistes, rhumatologues et gériâtres du Québec. Données statistiques, feb 1997.

119-Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992;45:613-619.

120-Romano PS, Roos LL, Jollis JG. Adapting a clinical comorbidity index for use with ICD-9-CM administrative data: differing perspectives. J Clin Epidemiol 1993;46:1075-1079.

121-Deyo RA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative data: a response. J Clin Epidemiol 1993;46:1081-1082.

122-Charlson ME. Adapting a clinical comorbidity index for use with ICD-9-CM administrative data: a response. J Clin Epidemiol 1993;46:1083-1084.

123-Romano PS, Roos LL, Jollis JG. Further evidence concerning the use of a clinical comorbidity index with ICD-9-CM administrative data. J Clin Epidemiol 1993;46:1085-1090.

124-Tamblyn R et al. The prediction of health care resource use and quality of care by licensure examination. NHRDP Project #6605-4101-57E.

125-Jollis JG, Ancukiewicz M, DeLong ER, Pryior DB, Muhlbaier LH, Mark DB. Discordance of databases designed for claims payment versus clinical information systems. Implication for outcomes research. Ann Intern Med 1993;119:844-850.

126-Malenka DJ, McLerran D, Roos N, Fischer ES, Wennberg JE. Using administrative data to describe casemix: a comparison with the medical record.J Clin Epidemiol 1994;47:1027-1032.

127-The Johns Hopkins ACG case mix system implementation guide, version 3.01. The Johns Hopkins University, Baltimore MD, June 1995.

128-Starfield BH, Weiner JP, Mumford LM, Steinwachs DM. Ambulatory care groups: a categorization of diagnoses for research and management. Health Serv Res 1991;26:53-74.

129-The Johns Hopkins ACG case mix system clinician's guide. The Johns Hopkins University,

Baltimore MD, July 1995.
130-Black C. Population-based measurement of primary care to study variations in care received by the elderly. Thesis dissertation. The Johns Hopkins University, Baltimore, MD, 1990.
131-Jollis JG, DeLong ER, Peterson ED, Muhlbaier LH, Fortin DF, Califf RM, Mark DB. Outcome of acute myocardial infarction according to the speciality of the admitting physician. N Engl J Med 1996;335:1880-1887.
132-Mcglynn EA, Naylor CD, Anderson GM, et al. Comparison of the appropriateness of coronary angiography and coronary bypass graft surgery between Canada and New York State. JAMA 1994;272:934-940.
133- Hilborne LH, Leape LL, BernsteinSJ, et al. The appropriateness of use of percutaneous transluminal angioplasty in New York State. JAMA 1993;269:761-765.

Acknowledgments

I am indebted to Jimmy Fragos for his work in the extraction of the present study variables from the source population data, and to Gisèle Mailhot for her editorial help.

I want to thank Dr Robyn Tamblyn for her support in the supervision of my thesis, and Dr James Hanley, Dr Linda Snell, and Dr Maurice McGregor who provided me with their comments and ideas inside and outside thesis comitee meetings.