Reducing potentially avoidable acute care transfers from long-term care homes: Developing a taxonomy of interventions and improving approaches to evaluate intervention effectiveness

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ABSTRACT

Potentially avoidable emergency department (ED) transfers and hospitalizations from long-term care (LTC) homes, providing 24-hour nursing care, represent an important quality of care challenge. These events are defined as those stemming from clinical conditions that theoretically could be managed onsite with appropriate primary care. They may occur contrary to residents' advance directives, expose residents to serious adverse events, and represent inefficiencies in healthcare systems. There are important limitations of research investigating interventions aimed at reducing transfers from LTC. These limitations make it challenging to adapt any proposed intervention to the needs and preferences of transfer decision-makers, mainly, primary care physicians, other front-line staff, LTC residents and their family members.

The primary aim of this dissertation was to conduct a series of methodological and substantive substudies to advance knowledge about potentially avoidable acute care transfers from LTC homes and the interventions aimed at their reduction. The secondary aim was to inform the design of future studies such that they can assess the impact of an exposure of interest that exists under regular conditions (non-experimental) on reducing a meaningful and contextually relevant outcome using causal inference methods.

In the first manuscript, I addressed the challenges related to the complexity of interventions that aimed at reducing ED transfers and/or hospitalizations among LTC residents experiencing an acute change in their health. Given the inconsistencies and confusion in the literature regarding intervention terminology, I conducted a systematic scoping review to propose a cohesive taxonomy of such interventions. In synthesizing 90 studies, I identified six intervention categories (e.g., *advance care planning, transitional care)*, and four intervention components (i.e., human resources, training, technology, tools).

In the second manuscript, I tackled the shortcomings in the literature surrounding measurement of acute care transfers from LTC. Using real-world data pertaining to a sample of Quebec LTC residents who received care in a tertiary hospital ED, I measured proportions of potentially avoidable ED transfers and hospitalizations associated with conditions manageable onsite and compared these proportions with those reported for the rest of Canada. A total of 1,233 transfers by 692 residents were recorded, among which 36.3% were classified as being potentially avoidable. *Potentially avoidable ED transfers with or without hospitalizations* accounted for 95%

of potentially avoidable transfers, and hence, were identified as an important LTC quality measure. Proportions of all outcomes in Quebec were comparable to those from the rest of Canada.

In the third manuscript, using acute care transfers from the LTC setting as a motivating example, I illustrated the usefulness of conceptualizing a causal diagram that encodes known or suspected associations between measured and unmeasured factors, the exposure of interest (*advance care planning*) and the primary study outcome (*potentially avoidable ED transfers*). I demonstrated how encoded information representing realistic study scenarios can be used to design and implement the Monte-Carlo simulation analyses using standard statistical software for repeated simulation.

This dissertation has implications for future research, clinical practice, and primary care policy-making. Findings provide important insights into proactive models of person-centred care in LTC homes. The proposed taxonomy of interventions can inform successful intervention designs and allow to draw meaningful conclusions about their effectiveness/efficacy in future literature reviews which would be necessary for eventual policy change. The results from these three dissertation manuscripts will inform future observational studies, including that of my research group which plans to conduct further investigation.

RÉSUMÉ

Les transferts potentiellement évitables vers les départements d'urgence et les hôpitaux en provenance des établissements de soins de longue durée (SLD), qui offrent des soins infirmiers 24 heures sur 24, représentent un défi important de qualité des soins. Ces transferts potentiellement évitables sont définis comme ceux qui découlent de conditions cliniques qui peuvent être gérées sur place avec des soins primaires appropriés. La recherche sur les interventions visant à diminuer ces transferts présente des limitations importantes.

Le but principal de cette thèse était de mener une série d'études méthodologiques et substantielles afin de faire progresser les connaissances sur les transferts potentiellement évitables vers les hôpitaux en provenance des établissements de SLD, et sur les interventions permettant de réduire ces transferts. Le but secondaire était d'informer la conception de futures études afin qu'elles puissent évaluer l'impact d'une exposition d'intérêt qui existe dans des conditions normales (non expérimentales) sur la réduction d'un résultat significatif et contextuellement pertinent en utilisant des méthodes d'inférence causale.

Dans le premier manuscrit, compte tenu des incohérences et de la confusion dans la littérature concernant la terminologie des interventions visant à réduire les transferts vers les urgences et/ou les hospitalisations chez les résidents en SLD, j'ai effectué une revue systématique de la portée afin de proposer une taxonomie cohérente de ces interventions. En synthétisant 90 études, j'ai identifié six catégories d'intervention (par ex., *la planification préalable des soins, soins transitoires)* et quatre composantes d'intervention (ressources humaines, formation, technologie, outils).

Dans le deuxième manuscrit, l'étude s'appuie sur des données réelles relatives à un échantillon de résidents en SLD du Québec qui ont reçu des soins dans un département d'urgence situé dans un hôpital tertiaire. J'ai mesuré les proportions de transferts potentiellement évitables vers les urgences et hôpitaux associés à des conditions gérables en SLD. 1233 transferts de 692 résidents ont été enregistrés, dont 36,3 % ont été classés comme potentiellement évitables. Les transferts aux urgences potentiellement évitables, avec ou sans hospitalisation, représentaient 95% des transferts potentiellement évitables et ont donc été identifiés comme une mesure importante de la qualité des soins en établissement de SLD. Les proportions de tous les résultats au Québec étaient comparables à celles du reste du Canada.

Dans le troisième manuscrit, j'ai illustré l'utilité de la conceptualisation d'un diagramme causal qui code les associations connues ou suspectées entre les facteurs mesurés et non mesurés, un exposant d'intérêt (la planification préalable des soins) et un résultat principal (transferts potentiellement évitables vers les urgences avec ou sans hospitalisation), en utilisant un exemple motivant. J'ai démontré comment les informations codées qui représentent des scénarios d'étude réalistes peuvent être utilisées pour concevoir et implémenter les analyses de simulation de Monte-Carlo à l'aide d'un logiciel statistique standard qui permet la simulation répétée.

Cette dissertation a des implications pour la recherche future, pratiques cliniques et l'élaboration de politiques en soins primaires. Les résultats fournissent des pistes de réflexion importantes sur les modèles proactifs de soins centrés sur la personne en établissements de SLD. La taxonomie d'interventions proposée peut servir de base à la conception et à la réussite d'interventions et tirer des conclusions significatives sur leur efficacité ou leur efficience dans les futures revues de la littérature, qui seraient nécessaires pour un éventuel changement de politique. Les résultats de ces trois manuscrits de thèse éclaireront de futures études d'observation, y compris celle de mon groupe de recherche qui prévoit de mener une enquête plus approfondie.

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LIST OF TERMS AND ABBREVIATIONS

ACSC	Ambulatory Care Sensitive Conditions
ACP	Advance Care Planning
CI	Confidence Interval
CHSLD	Centre d'hébergement et de soins de longue durée (LTC home French term used in Quebec)
CIUSSS	Centre intégré universitaire de santé et de services sociaux (French term used in Quebec for Network as defined below)
CIHI	The Canadian Institutes for Health Information
COVID-19	Coronavirus disease is an infectious disease caused by the SARS-CoV-2
Covidence	Systematic review management software
CRA	Centre for Research in Aging
CTAS	Canadian Emergency Department Triage and Acuity Scale (Appendix B)
ED	Emergency Department
EPOC	Effective Practice and Organisation of Care
HR	Human Resources
INTERACT	Interventions to Reduce Acute Care Transfers program
KTE	Knowledge Translation and Exchange
LPN	Licensed Practical Nurse
LTC	Long-Term Care
LTC Home	Long-Term Care Home (the study setting)
MedUrge	Electronic ED database (one of the "système d'information de gestion des urgencies (SIGDU)") used in Quebec Hospitals
MMAT	Mixed Methods Appraisal Tool
Network	Integrated Health and Social Services University Network
NRS	Non-Randomized Studies
NP	Nurse Practitioner
PAEDT	Potentially Avoidable Emergency Department Transfer
PAH	Potentially Avoidable Hospitalization
PCP	Primary Care Physician
PICO	Population, Intervention, Comparator, Outcome
RCT	Randomized Controlled Trial
Resident	A person living in a long-term care home (the study population)
RN	Registered Nurse
PRISMA-ScR	Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews checklist
RECORD	REporting of studies Conducted using Observational Routinely-collected health Data Statement
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology statement: guidelines for reporting observational studies.

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STATEMENT OF ORIGINALITY

The research in this thesis dissertation represents an original scholarship that advances knowledge pertaining to potentially avoidable acute care transfers from long term-care (LTC) homes. Via three manuscripts and through the lens of a causal inference framework, this doctoral work demonstrates an innovative approach to designing observational studies, informed by a systematic scoping review, a cross-sectional study, and data simulations.

To the best of my knowledge, the first manuscript is the most comprehensive systematic scoping review of interventions aimed at reducing potentially avoidable acute care transfers from LTC homes to date. It is the first review to propose a taxonomy of categories and components of interventions reporting emergency department (ED) transfers and/or hospitalizations (overall and potentially avoidable) from LTC as outcome measures, focusing on conditions that are 'manageable onsite', and having an explicit LTC home definition (i.e., 24-hour nursing care). It also provides substantial insights into many proactive models of person-centred care such as advance care planning.

The second manuscript makes key contributions to the scientific literature by showing that potentially avoidable ED transfers outweigh potentially avoidable hospitalizations in terms of frequency, underlining their importance as quality assurance measure in LTC homes. This is also the first time that these outcomes were evaluated in the province of Quebec and compared to the rest of Canada. This study suggests that improved mechanisms may facilitate not only monitoring of potentially avoidable hospitalizations but also potentially avoidable ED transfers.

The third manuscript showcases a data-driven approach to inform the design of a rigorous observational study and represents pioneering innovation in the LTC research on potentially avoidable acute care transfers. Informed by the first two manuscripts, this manuscript provides a step-by-step guide on how to simulate data and obtain actionable clues for an observational study design using the LTC clinical context as an example. This study proves that data simulations could help reduce confounding bias in estimating intervention effects via exploring how bias and variation in sample size affect inference.

The three manuscripts of this dissertation provide fundamental new knowledge about both clinical and nonclinical processes involved in potentially avoidable resident transfers to EDs and hospitalizations from LTC homes. The work produced in this thesis therefore serves as a step in the right direction to improve future LTC home and primary care practice guidelines and policies.

THESIS FORMAT AND CONTRIBUTION OF AUTHORS

This thesis is a manuscript-based dissertation comprised of three manuscripts. The first manuscript was published. The second manuscript is in press at the Canadian Geriatrics Journal. The third has been prepared for submission. Each article chapter contains a preamble that connects the manuscripts in a logical progression from one chapter to the next to document a single research program.

As PhD candidate and first author on all manuscripts in this dissertation, I originally developed the idea, objectives, and design for each substudy, organically connected the objectives of each substudy within the overarching research design, conducted the literature reviews, data collection, and data analyses, drafted all manuscripts, led the interpretation of findings and the finalization of the manuscripts, submitted them to journals.

All aspects of this dissertation were directed Dr. Machelle Wilchesky as my primary supervisor. As the Director of the Donald Berman Maimonides Centre for Research in Aging, Dr. Wilchesky ensured the partnership with the Network collaborators. Her expertise in dementia and LTC home research as an epidemiologist guided the methodology, the conduct and writing of the thesis, and interpretation of the results. Members of my Thesis Committee provided overall guidance on the protocol development and supported me with their specific expertise in its execution. Dr. Isabelle Vedel oversaw the aspects related to health services utilization by older adults and those having dementia. Dr. Mark Karanofsky, a practicing LTC home physician, is directly involved in improving the Network programs and quality within study sites. He confirmed the pertinence of the research questions for LTC home stakeholders and participated in the development of the study and interpretation of the results. Dr. Tibor Schuster is a biostatistician with expertise on the development and application of causal inference methods and observational research studies based on administrative or electronic health record data. He guided the development of the proposed causal inference methods, data simulations, and interpretation of results. Dr. Greta C. Cummings, Professor at Faculty of Nursing, University of Alberta, is a recognized expert in clinical nursing research, education, and knowledge translation nationwide. Dr. Cummings supported the aspects related to transitional care for LTC home residents.

I take the responsibility for the scientific integrity of this dissertation as my original doctoral work. The inclusion of all three articles in this dissertation was approved by all co-authors. A list of manuscripts with specific author contributions is provided below:

Manuscript 1: Deniz Cetin-Sahin MD, MSc, PhD(c), Greta G. Cummings RN, PhD, Genevieve Gore MLIS, Isabelle Vedel MD-MPH, PhD, Mark Karanofsky MDCM, CCFP, FCFP, Philippe Voyer RN PhD, Brian Gore MD, Ovidiu Lungu PhD, and Machelle Wilchesky PhD. Taxonomy of interventions to reduce acute care transfers from long-term care homes: A systematic scoping review. The Journal of the American Medical Directors Association. 2023; 24(3): 343-55. https://doi.org/10.1016/j.jamda.2022.12.025.

DCS led the conception and design, execution of the review, analysis and interpretation of data, and drafting, revisions and final approval of the article. MW led data acquisition, and contributed to the conception and design, interpretation of data, drafting, revision and final approval of the article. GGC, IV, and MK contributed to the interpretation of data, and revision and final approval of the article. GG contributed to the conception and design, data acquisition, interpretation of data, revision and final approval of the article. PV, BG, and OL contributed to the conception and design, interpretation of data, revision and final approval of the article.

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DCS led the conception and design, analysis, interpretation of data, and the drafting, revisions, and final approval of the article. MW led acquisition of data, and contributed to the conception and design, interpretation of data, drafting, revisions and final approval of the article. MK, GGC, and IV contributed to interpretation of data, drafting, revision and final approval of the article.

Manuscript 3: Deniz Cetin-Sahin MD, MSc, PhD(c), Machelle Wilchesky, PhD, Robert Platt PhD, Isabelle Vedel MD-MPH, PhD, Greta G. Cummings, and Tibor Schuster PhD. Monte-Carlo data simulations tutorial: A method to inform the design and analysis of observational studies illustrated using an example from the long-term care setting. To be submitted to The BMJ.

DCS led the conception and design, analysis and interpretation of results, drafting, and revisions. TS made substantial contributions to the conception and design, analysis and

interpretation of results, drafting, revisions, and final approval of the version for the thesis. MW, RP, IV, and GGC contributed to the interpretation of data, and drafting and revision of the work.

Ethics Approval

In this dissertation, one substudy involving human subjects was conducted according to the ethical principles for medical research outlined in the Declaration of Helsinki. Ethics approval was obtained from the Network West-Central Montreal Research Review Office (Medical-Biomedical Research Ethics Committee) (Project 2019-1580) (Appendix A). The Director of Professional Services of the Network approved the access to resident charts and to Med-Urge data.

Given that the systematic scoping review and data simulations used publicly accessible documents and software, without collecting personal, sensitive or confidential information from participants or individual participant data, these two substudies did not require ethics approval.

PREAMBLE

A vignette of a long-term care home resident and her daughter

An 80-year-old long-term care (LTC) home **resident** with moderate dementia, chronic obstructive pulmonary disease, and hypertension develops a new cough and low-grade fever on Friday evening. The last **interdisciplinary team** meeting where resident's care plans were discussed was held more than a year ago. The **nurse** notifies the **on-call physician** that the resident's pulse oximetry was 93%, which is their baseline value. The physician orders a respiratory viral panel, complete blood count, chest radiography, and vital signs to be read every 4 hours. At the time of the call, the resident has otherwise normal vital signs and appeared to be clinically stable.

On Saturday afternoon the chest radiography is returned as "chronic obstructive pulmonary disease changes, mild interstitial edema, clinical correlation advised." The respiratory viral panel is negative, labs are within normal limits, she is afebrile, pulse oximetry is now 92%, Pulse Rate 83/min, and Respiratory Rate 24/min. The **resident's daughter** is concerned that the physician will not be in the LTC home until Monday morning and insists that 911 be called for transfer to the hospital. There are no documented advance directives regarding transfer, intubation, or CPR. The **on-call physician** acquiesces and instructs the LTC staff to transfer the resident to the emergency department.

On **emergency department** presentation, the resident is alert and oriented to self only. Vital signs: Temperature 98.9, Pulse Rate 92, Respiratory Rate 26, Blood Pressure 130/87, pulse oximetry 90%. Lung exam reveals fair air movement, diffuse expiratory wheeze and rhonchi. The chest radiography and labs are consistent with Friday's findings.

The resident is **admitted to the hospital ward** with a diagnosis of chronic obstructive pulmonary disease exacerbation.

On Monday morning the resident develops significant respiratory distress and hypoxia with decreased alertness. Repeat chest radiography reveals bilateral reticular opacities. The **hospitalist** notifies the daughter of her worsening status who states, "We haven't really discussed her wishes if she were to become sicker. What do you think her chances are?"

Reflections:

Should the resident have been transferred to the emergency department? Should she be intubated?

What types of interventions might assist with management of such clinical situations in the LTC setting to reduce potentially avoidable acute care transfers?

How would advance care planning (e.g., Advance Medical Directives in Case of Incapacity to Consent to Care form or similar tools) guide care in this case?

This vignette was adapted to the general Canadian context from the following source:
Levine et al. COVID-19 in Older Adults: Transfers Between Nursing Homes and Hospitals. Journal of Geriatric Emergency Medicine. Volume 1, Issue 5. Newsletter March 27, 2020 https://gedcollaborative.com/jgem/vol1-is5-covid-19-older-adults-transfers-between-nursing-homes-and-hospitals/

I started my preamble with this vignette as it portrays the problem that I addressed in this dissertation. This problem requires solutions that involve not only LTC home frontline staff and administrators, but also residents' families and interdisciplinary teams. My research experiences focusing on various issues pertaining to transitional care for older adults, combined with my scientific background, have inspired me to pursue my doctoral work on reducing potentially avoidable acute care transfers from LTC homes.

My originally planned thesis dissertation included developing an 'observational study protocol' to investigate acute care transfers in a retrospective cohort of LTC home residents, designing and testing a chart review form and the electronic data capture platform to collect abstracted chart data, obtaining the ethics approval, and training the clinical research assistant to assist with chart reviews (Sept 2017- March 2020). I was ready to commence data collection, when this activity was interrupted due to the COVID-19 pandemic as a memo was sent out to researchers in our Integrated Health and Social Services University Network in Montreal suspending all non-COVID-19 related research activities at their sites. Since the first day of confinement on March 16, 2020, I have worked intensively on updating the systematic literature review that I had been leading at the Donald Berman Maimonides Centre for Research in Aging (CRA). I was actively involved in training the CRA team via Zoom meetings in conducting systematic reviews. I then supervised three Research Assistants who participated in study selection and data extraction for the update of the said systematic review, and quality appraisal for all articles included in the overall review. I redeveloped my thesis protocol, passed my comprehensive examination, and executed the protocol. I was unable to conduct originally planned chart review and subsequent analyses due to the pandemic. My prior dissertation work (i.e., from my original thesis protocol), however, was not completely abandoned. My original 'observational study protocol' is being revised such that it was informed by the results of the three substudies conducted in this thesis.

CHAPTER 1: INTRODUCTION

1.1 Problem

The Canadian Institutes for Health Information (CIHI) defines long-term care (LTC) homes as those that "serve diverse populations who need access to 24-hour nursing care, personal care and other therapeutic and support services".[1] In 2015-2016, 87% of Canada LTC residents suffered any form of cognitive impairment (including dementia and other conditions such as stroke or trauma), and 82% of them either required extensive assistance or were completely dependent for activities of daily living.[1]

Despite receiving 24-hour nursing care, these frail LTC residents are at high risk of being transferred to the emergency department (ED) during episodes of acute clinical decline.[2,3] Some of these transfers may result in hospitalizations. Among these acute care transfers, those for which "acute-care use might be reduced by timely and effective in-facility care" are defined as potentially avoidable.[4-7] In this dissertation, potentially avoidable acute care transfers are classified into two categories, namely **potentially avoidable emergency department transfers (PAEDTs)** and **potentially avoidable hospitalizations (PAHs)**. North American rate estimates of PAEDTs from LTC range from 25%[8] to 44%[6], and PAH estimates vary considerably, ranging from 23% to 67%.[5,9-11] Twenty-eight percent of transfers from LTC result in subsequent transfer within 30 days.[12]

Potentially avoidable acute care transfers are a growing concern for three main reasons. First and foremost, transfer to acute care sometimes occur in direct contravention of the needs and expectations of residents and their families, which is **contrary to the notion of 'person-centred care'**.[13] In their 2019 study, Nemiroff et al. reported that about half of LTC residents who were transferred to hospital had explicitly declared advance directives to the contrary.[14] A 2016 CIHI report indicated that 7% of hospitalized LTC residents had advance directives stating "do not hospitalize" (or "do not transfer").[15] In addition, 1–5% of LTC residents transferred to acute care die in the ED, once admitted, a further 5–34% of residents die in hospital.[3] Even though some of these transfers could be justified, some of them may occur at the end of life among LTC residents who are in their final stages of their diseases and therefore should theoretically transition to a comfort care approach.[16,17] Such transitions are common, ranging from 9.5%[17] to 19%.[18] They are associated with markers of poor quality in end-of-life care. Next, potentially avoidable acute care

transfers can be associated with **adverse transfer outcomes** due to reduced monitoring in the acute care environment[19] or the discontinuity of care that can result in communications gaps between care providers and institutions.[20] Adverse transfer outcomes may include delirium (38%),[21] nosocomial infections (41%),[22] adverse drug events attributable to medication changes (20%),[23] pressure ulcers (19%),[24] functional decline,[25] invasive interventions,[26] and other hospital-acquired complications.[27] Last but not least, such transfers represent an **inefficient allocation of health care resources** especially in the fast-paced ED and hospital settings.[28] For all these reasons, LTC primary care physicians, nurses, and other staff are directed to reduce potentially avoidable acute care transfers to improve the continuity, efficiency and quality of care for this frail population.[19]

1.2 Rationale

The growing clinical complexity of LTC home residents requires proactive models of person-centred care in this setting. To implement such models, the following five knowledge gaps in the literature must be addressed:

First, decision-making for transfers from LTC are multidimensional and can be influenced by many factors. Our current understanding of the interplay between these factors is incomplete. For this reason, interventions aimed at reducing transfers to acute care can be complex, involving multiple considerations and stakeholders. The current status of heterogeneity in the transfers intervention literature (due, in part, to an absence of a taxonomy) renders it difficult to ascertain the evidence[29] on the effectiveness and efficacy of these interventions which could ultimately guide clinical practices and policies.

Second, definitions of 'potentially avoidable' transfers are inconsistent and do not differentiate between conditions that are 'preventable (e.g., fall)' vs. 'manageable (e.g., pneumonia)' in the LTC setting. Third, the literature focuses on hospitalizations from the LTC settings as outcomes for interventions implemented at the LTC level, whereas it is the decision to transfer (and not to hospitalize) that is within the purview of the LTC clinical team. Taken together, there is a need to investigate all ED transfers, both with and without hospitalizations, with a focus on 'clinically manageable' medical conditions. This is especially true for the province of Quebec where there is a lack of real-world LTC data.

Fourth, randomized trials are considered to be the gold-standard in evidence-based medicine, but they are expensive, time-consuming, and often take place under artificial

exposure/treatment conditions that are not replicated in real-world health settings.[30] Non-randomized studies, on the other hand, are challenged by confounding bias. While current developments in causal inference methods offer a wide-ranging potential to avoid these limitations, they have been overlooked in the research literature investigating potentially avoidable acute care transfers from LTC homes. Fifth, we know that data-driven approaches are being promoted more and more as an alternative to analytical approaches. The uptake of these new approaches to clinical observational study design, execution, and analysis, however, remains low. There is a need for demonstrating the utility of data simulation methods in reducing design bias and increasing precision in observational studies.

These knowledge gaps render the selection, translation, and implementation of any proposed intervention to the needs and preferences of core LTC stakeholders (e.g., residents, their families, and LTC front-line staff) significantly challenging. As such, this dissertation addresses these gaps via the conduct of a series of methodological and substantive substudies to advance knowledge about potentially avoidable acute care transfers from LTC homes, and the interventions to reduce them. This work can also be used to inform the design of future studies such that they can assess the impact of an exposure of interest that exists under regular conditions (non-experimental) on reducing a meaningful and contextually relevant outcome using causal inference methods.

CHAPTER 2: REVIEW OF THE LITERATURE

2.1 Long-Term Care Homes and Acute Care Transfers

In this thesis 'long-term care homes' refer to facilities that provide indefinite care until the death of the resident. Centre d'hébergement et de soins de longue durée (CHSLD) is the French term used for LTC home in Quebec. I used the CIHI's definition of LTC home: 'facilities providing a wide range of health and personal care services for persons with medical or physical needs that require access to 24-hour nursing care, personal care and other therapeutic and support services for populations who are unable to remain at home or in a supportive living environment (e.g., assisted living facilities)'.[31] Facilities that did not provide around-the-clock professional services, but rather provided care to individuals at different points along the health care continuum (e.g., respite care,[32] rehabilitation, post-acute care), were not included within the scope of this dissertation.

Institutionalized LTC residents constitute a frail (mostly older adults) population, who suffer from multiple chronic diseases and functional or cognitive impairment, most commonly dementia. Dementia is currently known as major neurocognitive disorders, and is prevalent in (69% in 2015-2016) in Canadian LTC homes.[33] As our population ages, the number of Canadians with dementia is expected to double by 2038, resulting in a tenfold increase in demand for LTC placement.[34]

Long-term care home residents are often transferred to acute care during episodes of clinical deterioration.[4-7] Common reasons for transfer include infections, fall-related injuries, cardiovascular illnesses, mental status changes, gastrointestinal problems, and device-related complications (e.g., *percutaneous endoscopic gastrostomy tube or indwelling catheter)*.[26,35] The prevalences of potentially avoidable ED transfers or hospitalizations are considerably high, which could be up to 44%[6] and 67%[9], respectively. When appropriate, clinical management of episodes of acute health decline in the LTC setting itself (i.e., without transfer) is preferable.[28]

2.2 Conceptual Framework and Person-Centred Care

CIHI's 2013 Health System Performance Measurement Framework, which was adapted to LTC in 2015,[36] includes five concepts of the quality of services (Figure 2.1). These concepts are *appropriateness* (balancing benefits and risks of the services provided), *effectiveness* (reducing the

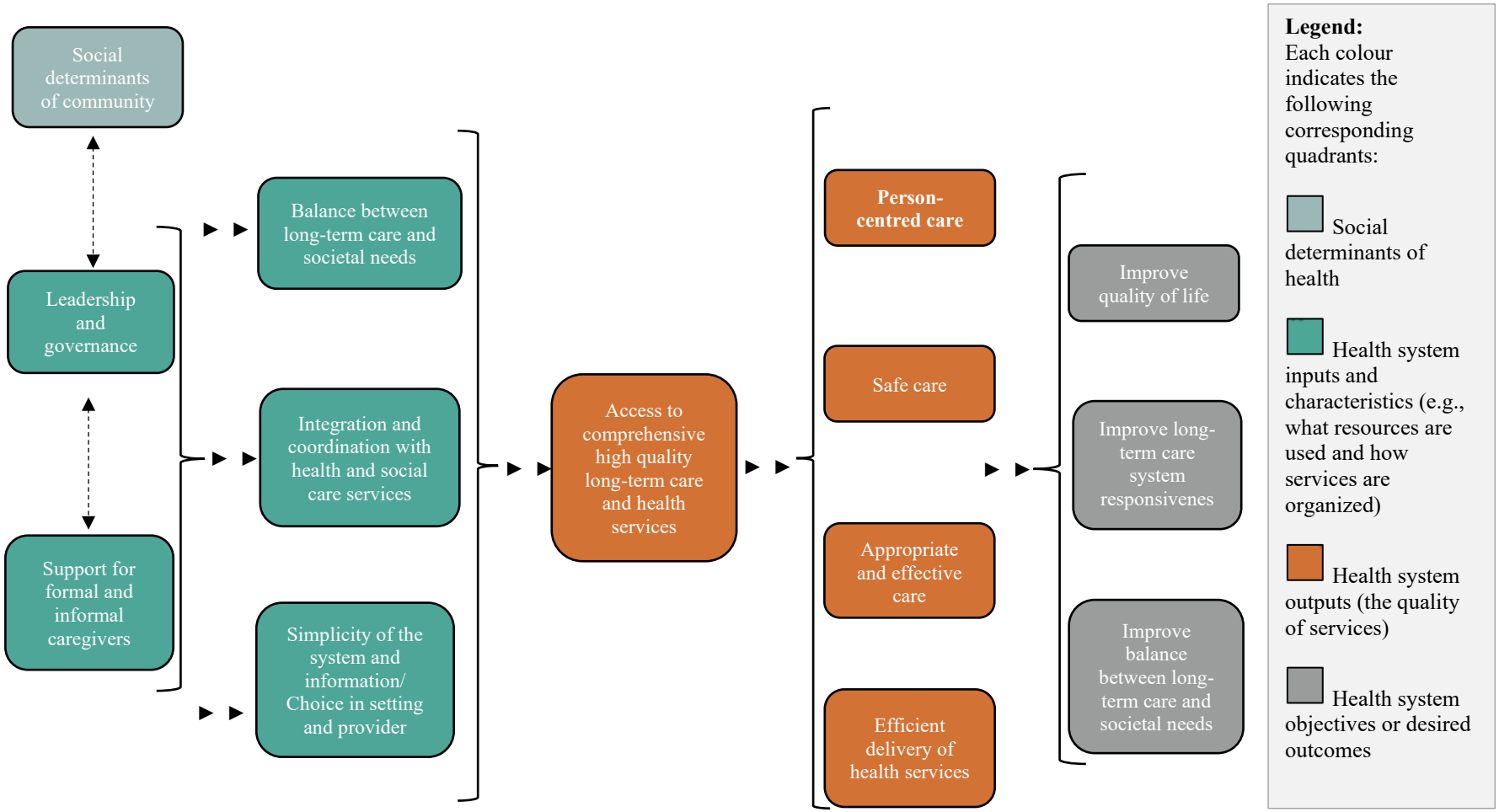
incidence, duration, intensity and consequences of health problems), *person-centredness* (respecting and responding to the preferences, needs and values of individuals), *safety* (reducing unnecessary risks without the potential benefits), and *efficiency* (avoiding waste of equipment, supplies, ideas and time/energy while maximizing quality). Acknowledging that reducing potentially avoidable acute care transfers from LTC is relevant to all five of these concepts, this thesis adopted this framework with a focus on the concept of **person-centred care** which is particularly aligned with family medicine and primary care.

In family medicine, the term "patient-centred care" was coined in the year 2000, and it initially revolved around the patient-doctor relationship. Since then, there has been a quest for its global definition in the literature.[37] In 2009, Berwick from the U.S. Institute of Medicine proposed that the term "patient- and family-centred care" include the experience of family and loved ones, [38] and this definition was then adopted by CIHI in 2013 as person-centred care.[39]

Transfer decision-making is complex and typically involves several core LTC home stakeholders, namely primary care physicians, nurses, residents, and families/substitute decision makers who represent (act as proxies for) residents.[40,41] Family members' participation in hospital transfer decisions and other treatment decisions, e.g., advance care planning (ACP) discussions, vary from no involvement to the insistence on a decision in favour of their personal preferences.[42] Conflicts between family members and health care providers mostly arise around the interpretation of resident's best interest, and family members usually perceive discussions as challenging and emotionally uncomfortable.[42]

Person-centred care encompasses the needs and expectations of residents and their families. It respects their right and desire for autonomy, confidentiality, dignity, choice of providers, and timely care.[36] This is in particular the case among residents with advanced dementia or other diseases who may experience burdensome acute care transfers at the end of life although a palliative approach to care is recommended for them.[43] According to a 2020 review,[16] the concept of "burdensome end-of-life transfers" revolves around the following definitions: "any transfer in the last 3 days of life, a lack of continuity of LTC before and after a hospitalization in the last 90 days of life (i.e., going from one LTC home to the hospital and then to another LTC home), and multiple hospitalizations in the last 90 days of life (i.e., either more than two hospitalizations for any reason or more than one hospitalization for pneumonia, urinary tract infection, dehydration, or sepsis in the last 90 days of life[18])".

Figure 2.1 Framework cascaded from the health system to long-term care



Source: Canadian Institute for Health Information, 2015. Health System Performance Frameworks: Aligning Frameworks for Sectors and Organizations to Health Systems

Additionally, LTC residents with advanced cognitive impairment who undergo two or more hospitalizations for the same type of diagnoses (urinary tract infections, pneumonia, septicemia, dehydration, or malnutrition) have poor survival.[44] While up to 19% of LTC residents experience at least one such transfer,[17,18] 50% of hospitalizations for residents in their last year of life are for potentially avoidable conditions.[45]

Lastly, it is not uncommon for discordance to exist between LTC residents' advance directives and inpatient resuscitation and hospitalizations.[15] It can be argued, then, that such discordance can be thought of as disrespecting the expectations of residents and their families, which would be contrary to the person-centred care paradigm. A study examining residents in 982 Canadian LTC home between 2009/10 and 2011/12 found that 1 in 5 residents had stated and documented "do not hospitalize" advance directives, about 7% of these residents were admitted to hospital, and that 47% of these hospitalizations were potentially avoidable.[15] Another study conducted in 10 LTC homes in Nova Scotia, Canada that included 748 residents reported that, among residents who were transferred to hospital, 74% were due to fall-related injury and 51% had explicit advance directives to the contrary.[14] In the LTC setting, therefore, the concept of person-centred care is particularly relevant to processes of care related to transfer decision-making, which is a delicate process that involves core stakeholders.

2.3 Review Methods

Two types of literature review informed this dissertation:

First, I conducted **a critical review**[46] of the conceptual and empirical primary studies and reviews reporting on factors associated with acute care transfers from LTC homes and/or interventions aiming to reduce them. I undertook a 'selective' search strategy since the aim was "to critically analyze the extant literature on a broad topic to reveal weaknesses, contradictions, controversies, or inconsistencies".[46] I performed a content analysis.[47]

Then, following an introduction to the casual inference framework, I provided an overview of the literature on use of data simulations in health care and health care research in general, and subsequently focused on studies using data simulation as a tool to improve clinical observational study designs. I used the term '**overview**' as a generic term for "any summary of the [medical] literature that attempts to survey the literature and describe its characteristics".[48] I took this approach since one of the perceived strengths of overviews is that they "can provide a broad and

often comprehensive summation of a topic area."[48] I performed a narrative synthesis of the relevant studies and reviews identified through Google and Google Scholar engines.

Five themes emerged from my knowledge synthesis: 1) Unexplained interplay between factors associated with and/or perceived as affecting transfers and the complexity of interventions targeting these factors to reduce them; 2) Challenges with 'potentially avoidable' transfer outcome measures stemming from inconsistent definitions; 3) Understudied outcome metrics, mainly ED transfers without hospitalizations; 4) Rare adoption of causal inference framework in designing observational studies on this topic; and 5) Low uptake of data simulations in observational health research design that maximizes the probability of achieving balance between comparison groups. In the next section, I summarize these themes followed by the knowledge gaps they revealed.

2.4 Summary of the Literature

2.4.1 Unexplained interplay between risk factors and complexity of interventions

The literature pertaining to factors associated with or perceived as affecting acute care transfers from LTC typically categorizes factors into four groups: resident/family factors, facility/resource factors, process/practice-related factors, and other potential factors. Risk factors associated with transfers include factors that were determined by quantitative studies that use statistical analyses. Factors perceived as affecting – mostly decision-making for – transfers include those that emerged via exploration of participants' perceptions in qualitative studies and analyses. Figure 2.2 presents a summary of these factors which were collected from the seven following reviews: A systematic review of factors associated with increased ED transfer in older LTC residents (Marincowitz et al., 2022[49]); a scoping review of 'reviews and all types of studies' assessing *ED transfers and hospitalizations* (Trahan et al., 2016[50]); a critical review of 'reviews and all types of studies' assessing *hospitalizations* (Ågotnes et al., 2016[51]), a systematic review of 'quantitative studies' assessing *ED transfers and hospitalizations* (Dwyer et al., 2015[3]); and three systematic reviews of 'qualitative studies' synthesizing perceived factors affecting *decision-making for emergency transfers* from LTC (Laging et al., 2015[40], O'Neill et al., 2015[52], and Arendts et al., 2013[41]

Figure 2.2 Factors associated with or perceived as affecting transfers from long-term care homes

1. RESIDENT/FAMILY LEVEL FACTORS	2. FACILITY/RESOURCE LEVEL FACTORS	3. PROCESS/PRACTICE-LEVEL FACTORS
Sociodemographic Factors	**Facility Characteristics**	**Knowledge And Skills**
Age, sex[49,51] Education, ethnicity[51] Socioeconomic status[51] Time since admission to LTC[26]	Facility for-profit status or size,[51] rural location,[49] Privately owned or part of corporate chain[3] LTC alignment with an acute hospital[3] Quality of LTC physical environment[3] LTC home quality rating[49]	Assessment[40,50,52] and management[50] skills PCP' s geriatric medicine knowledge[50] RNs' decision-making security[40,41,51,52]
Clinical Factors	**Staffing Characteristics**	**Communication Practices**
Presence of specific comorbidities (e.g., dementia, congestive cardiac failure, renal failure, diabetes)[49] Cognitive impairment[26] Permanent indwelling device (e.g., Percutaneous Endoscopic Gastrostomy tube)[26] Chronic respiratory or cardiac disease[26] Depression/ anxiety[26] Low body weight[26] Pressure ulcers[26] Recent falls[49] Lower functional ability[26] # medications/ # new medications[26]/ psychotropic medications[49]	Dementia specialist care[49] Staffing levels or ratios (e.g., with higher ratios of RNs to total nursing staff)[3,26,40,51,52] Workload[50,51] Rates of staff turnover[3,26,51] Primary care resources (supply of PCPs)[51] Number of PCP hours per resident Patterns of PCP practice[51] PCP availability to assess and consult[50] Access to PCPs' out of hours[51] Adequate staffing and skills mix[50]	Having consensus regarding LTC capabilities[40,51] LTC staff participation in the decision process[40] Knowing the LTC resident's condition, best interest, and advance directives[41,50,52] RNs' confidence in advocating on behalf of the resident[40] Standardized procedures for documentation of advanced directives[50,51] Knowing the family and keeping them informed[41,52] Communication between nursing and care staff and PCPs/NPs[50-52] Communication between family members, residents, LTC management and ED staff[52] Positive relationship with LTC resident, family members, and PCP/NP[50]
Advance Care Planning	**Resource-Related Reasons**	
Having an advance directive[26] Preferences at the time of advance care planning[50] Participation in end-of life decision making[51]	Presence of a dementia special care unit[3] Access to multidisciplinary services and resources[40] Presence of specialized geriatrician consultation[3] Prevalence of advance directives[3] Appropriate diagnostic equipment and services[41,52]	
Personal Reasons	**Health Care System**	**Delivery Of Care**
Family members' wishes for transfers at the time of actual decision[51] Confidence in care in LTC home[50] Expectation of better quality of life/ clinical outcomes[41,50]	Local health care policies[41,50,51] Bureaucratic issues/requirements determining care in LTC[50]	End-of-life care protocols in place[50,51] Quality of care-related PCP visits in the LTC[50] Adequate clinical care planning[41,50] LTC care providers' preferences[41]
4. OTHER POTENTIAL FACTORS		
Season/temperature[3]; Differences in PCPs' personal style, beliefs and education[51]; RNs' personal liability[50]; Attitudes of LTC PCPs, paramedics, and ED staff towards LTC staff[50,52]; PCPs' liability related to decision-making and treatment[50]; and RNs' unfavourable views about the care residents receive in hospital[52]		

PCP: Primary Care Physician; LTC: Long Term-Care; RN: Registered Nurse; LPN: Licensed Practical Nurse; NP: Nurse Practitioner

2.4.1.1 Resident and family level factors

The literature on resident/family level factors influencing transfers from LTC homes focuses on resident **sociodemographic** characteristics such as age, sex,[49,51] education, ethnicity, socioeconomic status, and time since admission to LTC.[51] **Clinical factors** including specific diagnoses are also important. For example, transfers to acute care have been shown to disproportionately affect residents with dementia who are more likely to be hospitalized.[2,53] Their clinical profile is masked by atypical presentations of symptoms that impede timely and accurate diagnoses, and communicating their needs in ways that staff can understand quickly is challenging.[54] All of these obstacles result in longer lengths of stay and poorer morbidity and mortality outcomes.[55] Resident/family participation in **advance care planning (ACP)**[56] and end-of-life decision-making[7,57] is reported as important. Insistence for transfers contrary to a previous ACP decision at the time when the actual decision is being made[58], or expectation of better quality of life and clinical outcomes for the resident[50], are some of the **personal reasons** affecting transfers**.**

2.4.1.2 Facility and resource level factors

Long-term care facility/resource level factors that contribute to acute care transfer usually fall within the following four categories: 1) **Facility characteristics** may include for-profit status (for-profit and chain affiliated LTC homes have higher rates of hospitalizations in the United States);[59] facility size (larger LTC homes hospitalize more often than smaller LTC homes in Canada);[60] being privately owned or part of corporate chain, rural location;[49] not being aligned with an acute hospital; and having lower quality of physical environment.[26] 2) LTC home **staffing characteristics** include dementia specialist care,[49] staffing ratios,[61] workload,[62] and turnover rates (higher turnover rates are associated with negative patient outcomes, including elevated rates of hospitalization),[5] regional variations in supply of physicians (residents were 1.82 times more likely to experience a preventable hospitalization if they resided in an area experiencing a primary care shortage),[63] patterns of physician practice[64] and access to physicians out of hours.[65] Findings on physician staffing and payment are not always conclusive and can be contradictory.[51] 3) **Resource-related reasons** may include poor access to multidisciplinary support,[40] absence of dementia special care unit,[49] specialized geriatrician consultation,[26] or lack of appropriate diagnostic equipment and services needed.[41,52] 4) The **health care system** affects transfers from LTC through

local health care policies (e.g., bed-hold policy,[66,67] which pay LTC homes to reserve the bed of acutely hospitalized residents[68]) and bureaucratic and legal concerns (e.g., the influence of government accrediting bodies not allowing the facilities the flexibility to care).[50]

2.4.1.3 Process and practice-level factors

Process/practice-level factors are related to decision-making, processes-of-care, and communication between front-line staff (primarily nurses, primary care physicians, where applicable, nurse practitioners, and other LTC staff) as well as their interactions with residents/families.[6,42,50] Decision-making for transfers[40,41] inherently occurs in the context of the availability of optimal management for specific conditions/situations in the LTC home.[69] Some process-level factors are related to gaps in staff's **knowledge** of geriatric medicine and/or **skill** in assessing and managing a deteriorating resident, or their fear of working outside their scope of practice.[7,50] Other factors have to do with **communication practices** among front-line staff and resident/families, which include a lack of common understanding of the LTC home's capacity to manage certain acute care conditions onsite, non-standardized procedures for documentation of advanced directives,[70] or challenges with efficiently communicating with other decision-makers.[40] **Delivery of care** is another aspect that affects decision-making. End-of-life care protocols in place[50,51] and quality care-related physician visits in the LTC home could prevent transfers;[50] nurses are more confident and decisive when there is some kind of plan in place, such as a policy, procedure, advance directive, medical care plan, hospital avoidance program, or informal plan of care or agreement.[41,50] Conflicting stakeholder preference (one stakeholder believes it is in the resident's interest to transfer to hospital and another does not) might have negative effects .[41]

2.4.1.4 Other potential factors

Other potential factors that are perceived to be affecting transfers are season/temperature,[26] differences in physicians' personal style, beliefs and education,[51] staff's liability related to decision-making and treatment,[50] and nurses' unfavourable views about their relationships with the ED staff and the care residents receive in hospital or sense of negativity and lack of respect from other health care professionals (physicians, paramedics and ED staff).[52]

2.4.1.5 Complexity of interventions: An illustrative example

Over the years, several types of complex interventions targeting abovementioned factors have been proposed and implemented to reduce acute care transfers from LTC homes. One notable large multicomponent intervention, "The Interventions to Reduce Acute Care Transfers (INTERACT) program" developed by Ouslander et al.,[71] includes the following:

1. Care path algorithms to assist front-line LTC staff in making decisions for residents with acute changes in condition by providing a systematic approach to the management of observed symptoms and signs such as fever, shortness of breath, or dehydration.

2. Communication tools including the *STOP and WATCH Tool* for identifying acute changes in condition, which is meant to be a clinical alert for a licensed nurse to determine if further evaluation is necessary; the *Situation, Background, Assessment, Recommendation Communication Form* and Progress Note, which is meant to guide the licensed nurse through a structured evaluation of the change in condition as well as prepare them for and structure communication with primary care clinicians; the *Nursing Home to Hospital Transfer Form* which is to be sent to ED nurses and physicians providing detailed information to assist them in making informed evaluation and management decisions for transferred residents; and the *Medication Reconciliation Worksheet* intended to provide guidance for the critical process of creating the most accurate list possible of all medications a patient is taking and comparing that list against the physician's admission, transfer, and/or discharge orders, with the goal of providing correct medications to the resident at all transition points and reducing adverse drug events.

3. Education materials for LTC staff, residents, and their families to undertake advance care planning at regular intervals (for example, twice a year[72] or at quarterly care planning meetings[71]) and whenever the resident's health deteriorates.[71,72]

2.4.1.6 Confusion around intervention categories and components

My preliminary examination of the literature assessing interventions that aimed at reducing transfers from LTC[73] suggested that interventions can be comprised of specific 'components' that are implemented to address different care situations that fall into specific 'categories'. One unresolved problem in the literature is that components and categories are sometimes used interchangeably, making it difficult to assess the specific components of the interventions that contribute to reducing transfers. This confusion is mainly due to the lack of a theory or framework

for such interventions. For example, studies where the primary intervention involved assessing the effects of adding nurse practitioners to the care team have often been categorized as being 'nurse practitioner interventions'.[74] However, the addition of nurse practitioners can also be thought of as being an intervention component, one which could be included within several different intervention categories. As a result, to date, knowledge syntheses on the effectiveness/efficacy of such interventions have been inconclusive,[74,75,76,77] suggesting the need for a clinically and methodically meaningful intervention taxonomy (classification system) tailored to this population and to these particular outcomes.[78]

2.4.1.7 Knowledge gap 1

The evidence suggests that decision-making for transfers is multifaceted. It involves considering residents' acuity and perceptions of both clinical- and resident-level stakeholders, legal ramifications, and availability of skilled staff, equipment, and other resources. Much less is known, however, about the interplay between these factors in shaping the components and categories of interventions. Patient-centred dimensions that determine the types of interventions are as follows: 1) *'When/ at what point'* residents are in their trajectory of LTC home stay (e.g., end-of-life) for the intervention to be appropriate, 2) *'For whom'* (e.g., individual resident characteristics such as having dementia or chronic diseases) the intervention is designed, and 3) *'How'* the intervention is expected to effect change. Hence, the evidence could benefit from a taxonomy that integrates these patient-centred dimensions. Development of this intervention taxonomy could then inform future intervention designs and harmonize estimation of intervention effectiveness and efficacy.

2.4.2 Challenges with 'potentially avoidable' transfer outcome measures

2.4.2.1 Inconsistent 'potentially avoidable' transfer definitions

The term 'potentially avoidable' in the context of acute care transfer from LTC settings describes events and situations that are heterogeneous. There is no absolute consensus in the literature on how to define 'unnecessary' or 'potentially avoidable' transfers.[35] The synthesis of the literature by Trahan et al. suggests that "a potentially avoidable acute care transfer measurement must be reliable but remain flexible enough to be generalizable to various LTC homes to meet the needs of resident care" and that definitions of avoidable transfers fall into one of the three following groups: 1) Management of early-acute or low-acuity symptoms and chronic disease in LTC, 2) Post-hoc assessment of factors contributing to avoidability, and 3) Ambulatory Care Sensitive Conditions

(ACSC) that can more appropriately be managed in LTC (e.g., pneumonia, urinary tract infections, and hypertension).[50]

Ambulatory Care Sensitive Conditions are generally defined as those that can be managed effectively in the community with appropriate medical screening, monitoring, management, and follow-up.[39,79] In community-based primary care, CIHI framework considers hospitalization for ACSCs as a proxy to measure access to comprehensive, high-quality primary care services[39] by focusing on 7 ACSCs (angina, asthma, chronic obstructive pulmonary disease, diabetes, epilepsy, heart failure, and hypertension).[80] Despite the lack of consensus on potentially avoidable acute care transfer definitions, there has been a growing consensus in the literature in which episodes of acute clinical decline, corresponding to specific ACSCs, could more appropriately be managed in the LTC. Transfers to acute care for these reasons would be 'potentially avoidable'.[81] When using the ACSC approach based on medical diagnoses, however, *preventable* conditions *and* conditions that are *manageable* in LTC are often combined together.[56,71] For instance, Walker's potentially avoidable hospitalization definition includes septicemia in potentially avoidable/manageable transfers even though transfers for this condition are typically considered unmanageable in LTC homes.[82]

As the concepts of preventing vs. managing acute conditions in LTC should be investigated separately due to their distinct focuses, in this thesis, potentially avoidable acute care transfers relating to ACSCs that are *manageable* in the LTC setting excluded conditions that are defined as being *preventable* such as falls or pressure ulcers. Potentially avoidable transfers were therefore defined as 'episodes of clinical decline corresponding to specific ACSCs that would more appropriately be managed in LTC homes'.[83]

2.4.2.2 Knowledge gap 2

There are challenges with measuring 'potentially avoidable' transfer outcomes as several definitions exist. Some include both *preventable* conditions (e.g., falls and trauma) and conditions that are *manageable* in LTC homes (e.g., pneumonia) as part of their definition. A focus on a definition that would prioritize transfers for conditions that are potentially *manageable* in LTC, and that would not include 'preventable' conditions is required. This approach would ultimately be beneficial to developing more focused and effective approaches for front-line staff who are faced with time-sensitive decisions pertaining to episodes of acute health deterioration by residents under their care.

2.4.3 Understudied outcome metrics

2.4.3.1 The literature focused on hospitalization outcomes

A portion of ED transfers do not result in hospitalization, and some of these transfers are also potentially avoidable.[83] Although decisions to hospitalize occur within the acute care setting, studies tend to focus only on hospitalizations or those that are potentially avoidable.[71,74-76] Measuring potentially avoidable hospitalizations therefore omits the essential first part of this process, which directly involves decision-making at the LTC level, namely potentially avoidable ED transfers (regardless of subsequent hospitalization outcomes). Hospitalizations from LTC were the predominant focus of the literature reviews as, to our knowledge, only one scoping review evaluated interventions to reduce preventable ED transfers from LTC.[84] Among the studies that measured ED transfers to date, only a few studies investigated readmission to ED from LTC,[12,85,86] and their primary outcome measures were usually all-cause ED transfers[12,86-93] rather than those that were potentially avoidable.[94] In fact, in their 2015 study, Burke et al. defined ED visits by LTC residents that did not lead to admission to hospital as potentially avoidable while those that led to admission were considered as less likely avoidable.[85]

In addition, the Continuing Care Reporting System that has been in place since 2003-2004 receives demographic, clinical, functional, and resource utilization information on individuals receiving services in hospitals or LTC settings in Canada (InterRAI).[95] The province of Quebec has no commitment to participate in this system.[96,97] As such, there is a lack of real-world Quebec LTC data, and rates of transfers and hospitalizations (both potentially avoidable and not), are unknown.

2.4.3.2 Knowledge gap 3

The literature indicates that interventions implemented at the LTC level aimed at reducing potentially avoidable acute care transfers should ideally reflect an outcome that is pertinent to local settings that are wholly controlled by LTC stakeholders. Given that decisions to hospitalize are rendered by acute care staff once a resident has already been transferred, there is a need to conduct a thorough investigation into potentially avoidable acute care transfers (i.e., transfers both with and without subsequent hospitalization), from LTC with a focus on conditions that are potentially manageable onsite.

2.4.4 Towards innovation in research on transfers from LTC homes

2.4.4.1 Causal inference frameworks

Randomized controlled trials (RCTs) are considered as the gold-standard for informing clinical practice and healthcare policies, yet they are expensive, time-consuming, and often take place under ideal exposure/treatment conditions that are not replicable in real-world settings.[30,98] Additionally, a cluster randomized trial design may be needed in certain settings (i.e., implementation of an intervention at the clinic, unit, or hospital level) for feasibility purposes that would require significant resources and special statistical analysis.[99] Observational studies can provide valid and reliable real-world evidence, especially for clinical situations that are unlikely to be randomized.[100]

Confounding is a major concern in any study, especially when trying to answer causal research questions.[101] Vanderweele proposes a formal definition of a confounder as "a pre-exposure covariance C for which there exists a set of other covariates X such that effect of the exposure on the outcome is unconfounded conditional on (X, C) but such that for no proper subset of (X, C) is the effect of the exposure on the outcome unconfounded given the subset".[102] In epidemiology, for a factor to explain the difference between 'the measure of association' and 'the measure of effect that would be obtained with a counterfactual ideal' and thus confound, "the factor must affect or at least predict the risk or rate in the unexposed (reference) group, and not be affected by the exposure or the disease."[103]

Causal inference methods offer extensive potential in estimating the average causal effects of *modifiable* risk factors in observational studies.[104] In epidemiology, these causes might be environmental exposures (e.g., pollution, occupational influences) or lifestyle factors (e.g., smoking, diet, alcohol).[105] In clinical epidemiology, exposures of interest may constitute therapies or drugs that are prescribed under regular (non-experimental) conditions.[106] In the broader field of primary care research, exposures may be preventive or health educational programs, screening methods, or other real-world healthcare exposures at the practice or community level.[107] As there are several modifiable factors that are linked to transfers from LTC, there is an opportunity to apply the causal inference framework.

The aim of causal inference methods is to emulate the unbiasedness of an RCT in the context of an observational study. Hernán & Robins describe that "causal inference from observational data revolves around the idea that the observational study can be viewed as a

conditionally randomized experiment".[104] In a causal inference framework, theoretically, every setting or person is exposed to the intervention and then, in a counterfactual world, every setting or person is withheld from the intervention, and their outcomes are compared. In reality, only one of the two counterfactual outcomes can ever be observed for each participant, which is called the 'fundamental problem of causal inference'.[104] Nonetheless, causal inference methods can be applied as long as the following three assumptions are valid: Consistency, Positivity, and Exchangeability. I explained how these assumptions might be violated by providing some scenarios for the illustrative INTERACT Program (assuming that the Program was put in place in the real-world in some jurisdictions as a quality initiative and the impact is considered in a non-randomized study context).[108]

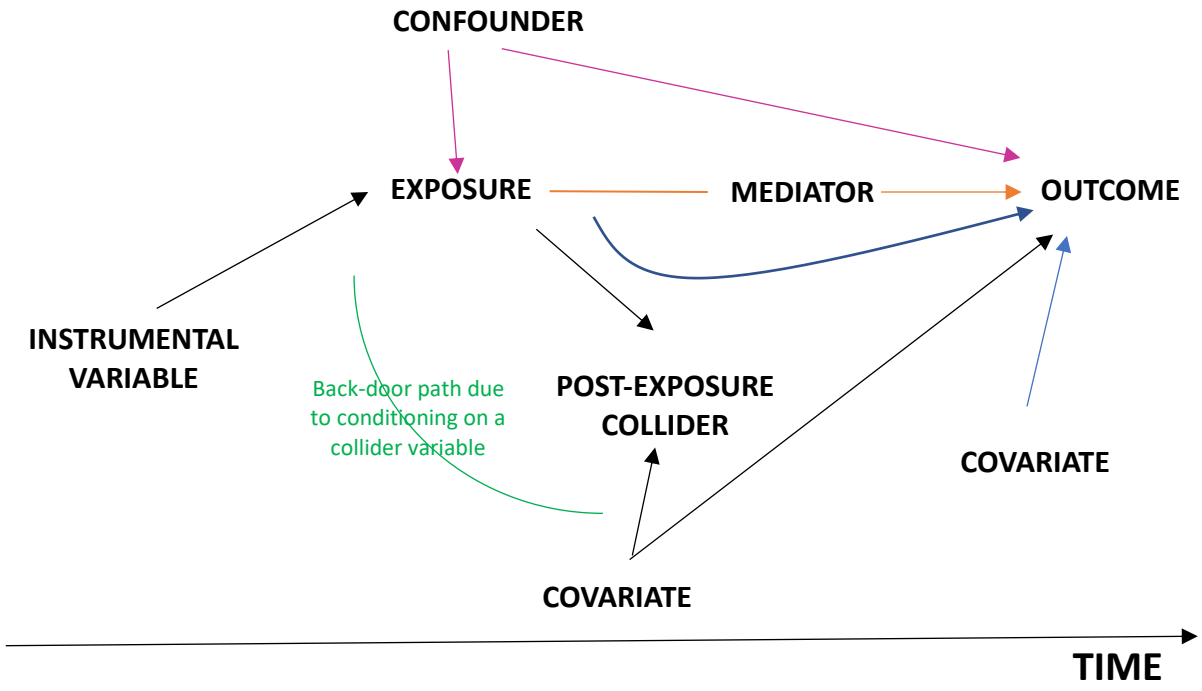
Consistency is ensured by asking the question, "Is the intervention well-defined and implemented in the same way for all subjects?" The two main components of consistency are a precise definition of the counterfactual outcomes via a detailed specification of the intervention, and the linkage of the counterfactual outcomes to the observed outcomes. For example, the INTERACT Program tools for decision-making, communication, and ACP should specify the exact LTC stakeholders who would be using them (e.g., physician, nurse, social worker), and stakeholders applying the intervention should adhere to the same intervention guidelines on roles and responsibilities in implementation. The challenge is that it would be difficult to attribute a single causal effect if there are variations in the intervention.[109]

Positivity asks the question: "Does every subject in the target population have a chance to receive or to not receive the intervention?" This means that the probability of receiving every value of treatment conditional on given covariates is greater than zero, i.e., positive.[104] In the INTERACT example, this would imply that any LTC home from the target setting could, in theory, have received the intervention. This condition might be violated, for example due to logistical barriers, if a LTC home undergoes a major change (such as a renovation, a pandemic outbreak, or an abrupt change in management) that precludes all residents in that facility from receiving the planned INTERACT program.

Exchangeability is assessed by asking the following question: "Are all confounders known and measured?" This means that if the patients in the intervention group were swapped with those in the comparison group, the expected difference in the outcome should remain unchanged.[104] In the case of non-randomized allocation of interventions, which may occur even in

the presence of randomization, there are usually imbalances or systematic differences in the characteristics of the patients in each group. For example, a LTC home receiving the INTERACT program may have higher rates of transfers at baseline, be larger in size (bed capacity), or have differences in staff to resident ratios. Likewise, residents receiving an ACP component of the intervention may be older, have more severe dementia, have more comorbidities, etc. In an observational study setting, therefore, the potential impact of unmeasured confounding on effect estimates should be investigated given that the exchangeability assumption will often be unsatisfied.[101] Causal diagrams, also called **Directed Acyclic Graphs (DAGs)**, can be helpful in this regard if something is known about the causal structure relating all of the variables to each other.[104] Figure 2.3 illustrates an example DAG.

Figure 2.3 An example directed acyclic graph



When it is known that there are important **confounders** that cannot be measured, there will be residual bias in causal estimates. In this case, there are other methods that can validly estimate causal effects under an alternative set of assumptions that do not require measuring all adjustment factors. **Instrumental variable** estimation is one such method.[104] A variable can be 'an instrument' when it meets three instrumental conditions: 1) It is associated with exposure, 2) it

does not affect outcome except through its potential effect on exposure, and 3) It does not share any causes with the outcome (i.e., it cannot be influenced by other unmeasured predictors of the outcome).[104] Three commonly used categories of candidate instruments are genetic factors,[110] a physician's (or a care provider's) preference for one treatment over the other,[111] and access to the treatment.

The exchangeability condition may also be violated when adjusting for certain variables such as mediators and colliders.[112] **Mediator** variables are those that lie on the causal pathway between exposure and outcome, and are important for the differentiation between direct and indirect effects.[109] Indirect exposure effects involve changes of an outcome through changes in mediator levels caused by changes in the exposure status. Decomposing the total causal effect of an intervention into direct (navy arrow) and indirect or 'mediated' (orange arrows) causal effects may be of an interest in scenarios where it may be more feasible or cost-effective to intervene at the level of the mediator rather than the exposure in order to affect the outcome.[109] **Colliders** have two or more direct 'ancestors' (i.e., two variables that causally predict the collider variable). Problems arise if collider variables that follow exposure are adjusted for in the analysis (e.g., conditioning on a collider). Conditioning on the common effect conveys an association between two otherwise independent variables (opens the back-door path), which introduces selection bias.[113]

2.4.4.2 Lack of the use of causal inference frameworks in LTC home research

Research evaluating the impact of interventions on potentially avoidable acute care transfers from LTC so far have typically used conventional analytic approaches. While randomized evaluations are not feasible in all cases (i.e., more expensive, time consuming, and sometimes ethically impossible to randomize),[30] non-randomized studies commonly use multiple health administrative healthcare services claim databases which may lack detailed information about individual resident and facility characteristics, and information pertaining to care processes.[51] The relevance of important clinical and process factors at the time that transfer decisions are made are often omitted (e.g., symptoms, vital signs, or communication) as they are usually not available in administrative databases. There is little usable data at the resident and process levels – in depth nature – that can be translated into person-centred actions.

To date, few studies attempted to apply causal inference methods on this topic. Hirsh et al. investigated the effect of nursing home ownership (i.e. public vs private) on hospitalizations of

long-stay residents using an instrumental variable approach.[59] Gozalo et al. evaluated causal effect of hospice enrollment ("Medicare Hospice Benefit" need which is certified by patients' doctor and the hospice medical director as having a terminal prognosis of 6 months or less) on hospitalization of dying LTC patients and found that hospice selection introduced some bias.[114] Otherwise, observational study evidence on potentially avoidable acute care transfers from LTC homes was usually on associations where the case for causal inference cannot be made as the differences observed could be due to unmeasured confounders.[75]

2.4.4.3 Knowledge gap 4

There is a paucity of research investigating acute care transfers from LTC homes adopting a causal inference framework. Many modifiable processes of care (exposures existing under regular conditions) offer observational study opportunities to assess the degree to which they could have a causal effect on reducing potentially avoidable acute care transfers from LTC. These methods can be applied in this clinical context where randomizations may be infeasible for certain intervention categories for many practical, ethical, and political reasons.

2.4.5 Data simulations and healthcare research

2.4.5.1 Analytical vs data-driven approaches to confounding control

More recently developed statistical methods are now available to deal with above-mentioned issues, suggesting a shift from an analytical approach (hypothesis driven) to data-driven approaches.[115] In an analytical approach, the design of observational studies rely heavily on the expertise of analysts where "process of expert consideration, introspection, anecdote, and discussion leads to a particular design".[115] Thus, the analysis essentially involves making decisions about confounder control based on substantive knowledge. However, these decisions are often made without having much knowledge of the underlying causal structures and without knowing for certain whether adjustment for particular covariates will reduce bias (the nature of the covariates).[116]

An alternative path to study design is a data-driven approach.[115] While data-driven approaches do not eliminate the need for substantive knowledge in confounder selection decisions, they are "motivated by the fact that there is far more covariance data that is available than is possible to adjust for in a standard regression model, especially when the number of covariates is relatively large and the sample size is relatively modest".[116] One approach to gain a better

understanding of the anticipated results and their sensitivity to violations of underlying assumptions is data simulation, such as Monte-Carlo studies.[117] In general, the flexibility of Monte-Carlo simulations allows to vary risk assumptions under all parameters and to model a range of possible outcomes (so-called randomness in both the inputs and outputs).[118] While analytical approaches make certain assumptions for modelling data, simulations help us graphically represent how things might look under a wide range of possibilities, get a feeling of the behaviour of the system under consideration, and reduce uncertainty. For this reason, simulation studies are mostly developed iteratively. The process often starts by making many simplifying assumptions of the reality. The model is evaluated and often revised or updated as certain assumptions are judged plausible and others are not. This iteration process continues until an adequate level of understanding is developed and the research question can be answered.

2.4.5.2 Use of data simulations in healthcare and healthcare research

As mentioned above, with the recent paradigm shift from analytical approaches to data driven approaches,[115] data simulation became a tool to examine questions of interest by using computer-generated data to study properties of statistics and estimating algorithms.[119] Technological advancements in modern statistical software have made data simulation approaches feasible for stakeholders, such as government/policy makers (**in policy making**), clinicians working in healthcare and healthcare research (**in clinical practice**), and researchers (**in quantitative research settings**).[119]

In policy making, data simulations have eventually had widespread application in healthcare and healthcare delivery systems for various problems such as patient flow, staffing, work schedules, facilities' capacity and design, admissions/scheduling, appointments, logistics, and planning.[120] They have also been used to address the complexity associated with ensuring the effective use of immunization for communicable disease, screening, and costs and economic evaluation.[121]

In clinical practice, data simulations are considered in a decision-making context. For example, there might be rare cases where clinicians need to make decisions (e.g., about individuals with psychiatric/education diagnosis, atypical symptoms). In these populations, often there is very limited data available to test clinical hypotheses that are generalizable to other cases. By simulating large quantities of data that mimic real-world clinical situations,[107] it is possible to understand the consequences of different decisions (i.e., rather than using indirectly relevant data or intuition).[119]

In quantitative research settings, simulation studies were initially conducted for the evaluation of new methods or for the comparison of alternative methods. For example, synth-validation procedures are proposed to estimate the estimation error of causal inference methods applied to a given dataset.[122] In such procedures, the observed data are used to estimate generative distributions with known treatment effects, each causal inference method is applied to datasets sampled from these distributions, and the effect estimates with the known effects are compared to estimate error. To ensure that the simulation strategy is producing realistic data that closely matched the observed data, observed and simulated data can also be compared in order to evaluate pharmacoepidemiologic methods in complex healthcare databases.[123]

Simulation studies were later found useful in planning and designing studies while making certain assumptions for the level of measurement of the variable, the method of sampling, the shape of the population distribution, and calculating sample size or power.[119] Data-driven approaches to clinical observational study design, execution, and analysis shows promise as an alternative to traditional analytical approaches, but they are relatively underutilized for these purposes.[115] They are commonly used for evaluating analytic strategies to compare relative performance of one method versus another, some studies addressing clinical questions and others evaluating more generic approaches.

Studies addressing clinical questions often used simulations to compare statistical approaches in dealing with confounding in various drug effectiveness studies.[115,124-128] Simulations also permitted investigators to study the issues regarding unadjusted treatment comparison, patient characteristics comparison, and confounder adjustment in the nephrology literature.[129] Other studies tested the performance of the methods investigating the relationships between various exposures and outcomes, such as teenage pregnancy and low birth weight,[130] sustained virological response and liver fibrosis progression among persons infected with the hepatitis C virus,[131] body mass index and blood pressure/lipid levels,[132] or highly active antiretroviral therapy and increased blood CD4 counts.[133]

Studies evaluating more generic methodological approaches pertained to addressing partially misspecified causal diagrams,[134] comparing of multiple imputation methods for handling missing values,[135] evaluating both traditional analytical methods (e.g. regression, propensity score weighting, stratification, and matching) and more recently proposed approaches (tree-based methods, local control, entropy balancing, genetic matching, prognostic scoring),[136] testing causal

effects in observational survival data using propensity score matching design,[137] evaluating weighting methods based on propensity scores to reduce selection bias in multilevel observational studies,[138] or discussing generalizability of causal inference in observational studies under retrospective convenience sampling.[139]

2.4.5.3 Knowledge gap 5

In observational studies, imbalances in outcome measures (e.g., rates of transfers) at baseline challenges analysis and interpretation of evaluations. This highlights the value of adopting a design strategy that maximizes the probability of achieving balance. Data simulations can help reduce bias by confounding in estimating intervention effects via exploring how bias, errors, and variation across settings affect inference and evaluating the behaviour of new methods with known ground truth. They can also help better calculate sample size for observational studies. Although simulation studies (especially those using Monte-Carlo methods) are common in statistical research, there remains opportunity for increasing their use in designing observational studies.

CHAPTER 3: KNOWLEDGE GAPS AND THESIS OBJECTIVES

3.1 Summary of the Literature Review

Due to mounting complexity of potentially avoidable acute care transfers, proactive models of person-centred care are needed in the LTC homes that provide 24-hour nursing care. Currently, the literature suffers from five knowledge gaps as shown in Table 3.1.

Table 3.1 Summary of knowledge gaps pertaining to acute care transfers from LTC homes

	WHAT IS KNOWN ABOUT THIS TOPIC	KNOWLEDGE GAPS
Gap 1	Several interplaying risk factors influence decision-making for transfers from LTC homes, making interventions aimed at reducing transfers complex	A taxonomy of interventions to guide meaningful synthesis of their effectiveness/ efficacy is absent
Gap 2	There are challenges with inconsistent definitions for 'potentially avoidable' transfers from LTC	There is a lack of evidence that focuses on medical conditions that are 'clinically manageable' in the LTC setting
Gap 3	There are challenges pertaining to understudied transfer outcome metrics	There is a lack of evidence about ED transfers as outcomes, both with and without subsequent hospitalizations
Gap 4	RCTs and observational studies have their own shortcomings in informing healthcare policies, and causal inference methods provide alternative approaches for the reduction of confounding bias and precision improvement in observational studies	Causal inference framework methods have rarely been applied in the clinical context of reducing potentially avoidable acute care transfers from LTC homes
Gap 5	Data-driven approaches such as Monte Carlo simulations are being promoted as an alternative to analytical approaches	The uptake of data-driven approaches to clinical observational study design, execution, and analysis remains low

3.2 Aims and Objectives

The primary aim of this dissertation was to conduct a series of methodological and substantive substudies to advance knowledge about potentially avoidable acute care transfers from LTC homes and the interventions to reduce these transfers. **The secondary aim** was to inform the design of future studies such that they can assess the impact of an exposure of interest that exists under regular conditions (non-experimental) on reducing a meaningful and contextually relevant outcome using causal inference methods.

The specific objectives were to:

1. Develop a taxonomy of interventions that aimed at reducing ED transfers and/or hospitalizations (either all transfers or those deemed to be potentially avoidable, or both) by LTC home residents experiencing an acute change in their health. More specifically, I sought to answer the following questions:
    a. Which interventions have been assessed in the literature?
    b. Under which categories do these interventions fall?
    c. What intervention components were required to implement these interventions?
    d. Which outcome(s) have been measured (all ED transfers and/or hospitalizations, only those deemed to be potentially avoidable, or both)?
2. Operationalize potentially avoidable ED transfers and hospitalizations as being outcome measures for conditions that are theoretically 'clinically manageable' in the LTC setting. More specifically, my objectives were to:
    a. Measure proportions of potentially avoidable ED transfers and potentially avoidable hospitalizations received at a large tertiary acute care setting from a LTC home sample in the Province of Quebec, and
    b. Compare the Quebec findings with those reported for the rest of Canada.
3. Demonstrate the utility of Monte-Carlo data simulations to inform the design and analysis of observational studies in clinical care settings. Using the motivating example designing an observational study adapting a causal inference framework to estimate the impact of an exposure of interest (advance care planning) on a primary study outcome (potentially avoidable emergency department transfers), my objectives were to:
    a. Describe Monte-Carlo data simulations,
    b. Provide step-by-step guidance for Monte-Carlo study implementation using standard statistical software that enables repeated simulation of realistic study scenarios to:
        i. Assess the potential magnitude of biases and performance of the statistical inference models to be used for analysis, and
        ii. Estimate the statistical power and minimum sample size needed to detect clinically relevant effect sizes.
    c. Discuss the limitations of data simulations and how to mitigate them.

To achieve these objectives, I conducted three substudies resulting in three manuscripts:

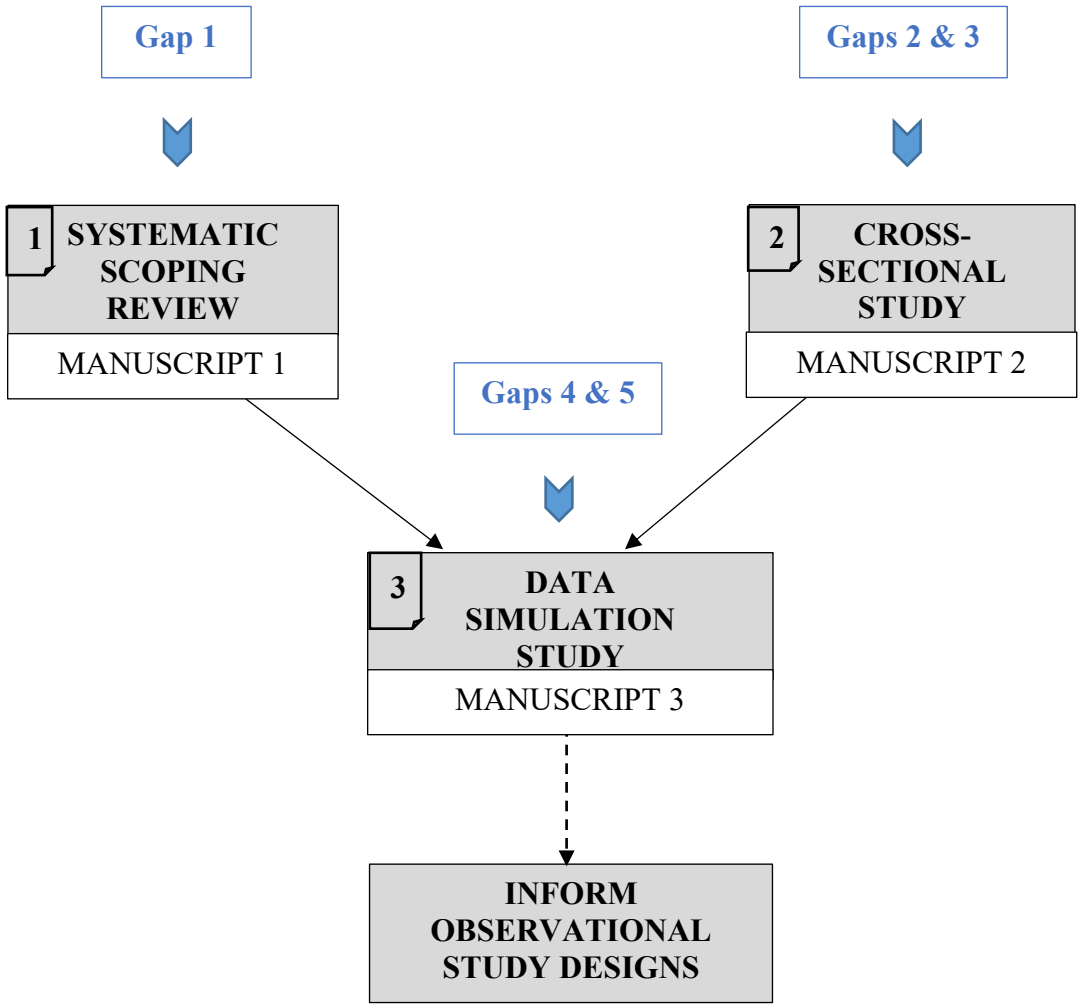
Substudy 1: A Systematic Scoping Review,

Substudy 2: A Cross-sectional Study, and

Substudy 3: A Data Simulation Study.

Figure 3.1 presents the relationships between these three substudies, and the path to which the next step will be reached, namely developing a study protocol to execute.

Figure 3.1 Three thesis substudies



CHAPTER 4: TAXONOMY OF INTERVENTIONS TO REDUCE ACUTE CARE TRANSFERS FROM LONG-TERM CARE HOMES: A SYSTEMATIC SCOPING REVIEW (MANUSCRIPT 1)

4.1 Preamble

Before commencement of my PhD studies, I had developed a larger systematic mixed-studies review protocol in collaboration with my current supervisor. The goal of this protocol was to answer the following questions:

1) What are the characteristics of existing interventions designed for LTC home stakeholders as a means to:

(A) reduce potentially unnecessary acute care transfers in the event of an acute or complex change in residents' health; and

(B) improve the transition of care from LTC home to acute care settings in the event that a resident requires a transfer?; and

2) What is the effectiveness of these interventions (both as a whole and in terms of their sub-components)?

Academic and knowledge user clinicians and decision makers provided input so that the review questions were framed appropriately and addressed issues important to those delivering care in LTC homes. I collaborated with a liaison librarian for Family Medicine at McGill University, who guided the search strategy and performed the initial searches in July 2016.

A preliminary examination of identified articles indicated a lack of taxonomy of our interventions of interest, which precluded the synthesis of their effectiveness/efficacy. Interventions appeared to be comprised of specific 'components' within different 'categories'. However, these terms have been used interchangeably, creating complexity in the literature. In this thesis, intervention 'categories' are described as a function of 3 specific intervention dimensions as follows: 1) *'When'/ 'at what point(s)'* on the continuum of LTC care (e.g., at admission, throughout stay, when acute situations develop, or at end-of-life) the intervention would be appropriate; 2) *'For whom'* the intervention would be targeted (e.g., all LTC residents, or a sub-population of residents, such as those with chronic conditions); and 3) *'How'* the intervention is expected to effect change. Intervention 'components' are the logistical elements within the

interventions themselves that are implemented to solve specific care problems and have the potential to causally influence outcomes (e.g., improved technology and enhanced resources).

For the purpose of this thesis, I developed new review objectives such that the findings of this current knowledge synthesis (Manuscript 1) would inform this thesis. My overarching goal was to develop a taxonomy of interventions aimed at reducing ED transfers and/or hospitalizations among LTC residents experiencing an acute change in their health. My specific objectives for this first substudy were to answer the following research questions:

1. Which interventions have been assessed in the literature?
2. Under which categories do these interventions fall?
3. What intervention components were required to implement these interventions?
4. Which outcome(s) have been measured?

To achieve these objectives, the original database searches were updated in March 2020. I executed a systematic scoping review (below) that included experimental and comparative observational intervention studies that used quantitative or mixed methods (excluding non-comparative descriptive and qualitative studies). The rationale to include non-randomized studies in this review was twofold. First, randomized controlled trials addressing homogenous 'Population, Intervention, Comparator, Outcome' questions were expected to be few in number. In addition, certain interventions may not be amenable to randomization (e.g., impact of changes in healthcare policies on transfer reduction in mixed LTC settings), and I did not wish to exclude these studies based on study design alone. As such, this review presents the most comprehensive overview of this topic to date.

This is the first of three thesis manuscripts. Findings from this substudy informed the third substudy, in that it helped me prioritize both a transfers intervention category (i.e., an exposure existing in real-world situations meeting the criteria for inclusion in the directed acyclic graph) and an appropriate set of confounders (for which controlling is critical to achieve reliable causal inference modeling).

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Title: Taxonomy of interventions to reduce acute care transfers from long-term care homes: A systematic scoping review

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4.2 Abstract

Objective: To develop a taxonomy of interventions aimed at reducing emergency department (ED) transfers and/or hospitalizations from long-term care (LTC) homes.

Design: A systematic scoping review.

Setting and participants: Permanent LTC home residents.

Methods: Experimental and comparative observational studies were searched in MEDLINE, CINAHL, Embase Classic + Embase, The Cochrane Library, PsycINFO, Social Work Abstracts, AMED, Global Health, Health and Psychosocial Instruments, Joanna Briggs Institute EBP Database, Ovid Healthstar, and Web of Science Core Collection from inception until March 2020. Forward/backward citation tracking and grey literature searches strengthened comprehensiveness. The Mixed Methods Appraisal Tool was used to assess study quality. Intervention categories and components were identified using an inductive-deductive thematic analysis. Categories were informed by three intervention dimensions: 1) 'when/at what point(s)' on the continuum of care' they occur; 2) 'for whom' (i.e., intervention target resident populations); and 3) 'how' these interventions effect change. Components were informed by the logistical elements of the interventions having the potential to influence outcomes. All interventions were mapped to the

developed taxonomy based on their categories, components, and outcomes. Distributions of components by category and study year were graphically presented.

Results: 90 studies (25 randomized, 23 high quality) were included. Six intervention categories were identified: 'Advance care planning', 'Palliative & end-of-life care', 'Onsite care for acute, sub-acute, or uncontrolled chronic conditions', 'Transitional care', 'Enhanced usual care' (most prevalent, 31% of 90 interventions), and 'Comprehensive care'. Four components were identified: 'Increasing human resource capacity' (most prevalent, 93%), 'Training or reorganization of existing staff', 'Technology', and 'Standardized tools'. The use of technology increased over time. Potentially avoidable ED transfers and/or hospitalizations were measured infrequently as primary outcomes.

Conclusions and Implications: This proposed taxonomy can guide future intervention designs. It can also facilitate systematic reviews and precise effect size estimations for homogenous interventions when outcomes are comparable.

4.3 Introduction

Residents living in long-term care (LTC) homes that provide 24-hour nursing care have complex health problems and/or are dependent in activities of daily living.[1] These frail residents are frequently transferred to the emergency department (ED) during episodes of acute health decline.[2] Transfers for episodes that could be managed by timely and effective in-facility care are commonly defined as "potentially avoidable".[3,4] Reported prevalence estimates of potentially avoidable ED transfers and subsequent hospitalizations are considerably high, at up to 44%[5] and 67%,[6] respectively. When appropriate, it is recommended to clinically manage acute episodes within the LTC setting itself in order to maintain continuity of care,[7] reduce transfer-related adverse events,[8] and promote the efficient use of health resources.[9]

Transfer decision-making processes from LTC are influenced by factors related to residents/families, facility characteristics/resources, and local care processes/practices.[10] Interventions aimed at reducing transfers and/or hospitalizations from LTC by acting on these factors are comprised of specific components implemented to address specific needs at certain point(s) on the continuum of care' (e.g., end-of-life). However, confusion exists in the literature in this field, and terms such as 'categories' and 'components' have been used interchangeably, mainly due to the lack of a theory or framework for such interventions. For example, studies where the

primary intervention involved assessing the effects of adding nurse practitioners to the care team have often been categorized as being 'nurse practitioner interventions'.[11] However, the addition of nurse practitioners can also be thought of as being an intervention component, one which could be included within several different intervention categories. This type of inconsistency in the literature exacerbates the heterogeneity of the terminology, making it difficult to compare and assess specific intervention attributes that contribute to reducing transfers from LTC.[12] This speaks to a need for a clinically and methodically meaningful intervention taxonomy tailored to this population and these particular outcomes.[13]

The heterogeneity in outcome reporting among studies evaluating ED transfers and hospitalizations represents another key challenge. Many intervention evaluation studies have focused on reductions in hospitalizations among LTC residents as a primary outcome.[11,12,14,15] Transfers to the ED, however, are – arguably – a more relevant outcome measure for interventions implemented at the LTC-level, given that they are directly controlled by LTC stakeholders (i.e., residents, families, and staff). To our knowledge, only one scoping review to date has evaluated interventions to reduce preventable LTC transfers to the ED.[16] That review, however, did not sufficiently address the clinical heterogeneity associated with study designs, outcomes, and intervention categories and components.[16]

Given these shortcomings in the literature, the aim of this systematic scoping review[17] was to develop a taxonomy (i.e., a classification system)[18] of interventions aimed at reducing ED transfers, both with and without subsequent hospitalization, from the LTC setting. In this paper, intervention 'categories' are described as a function of three (3) specific intervention dimensions, as follows:

Dimension 1: *'When/ at what point(s)'* on the continuum of LTC care (e.g., at admission, throughout stay, when acute situations develop, or at end-of-life) the intervention would be appropriate;

Dimension 2: '*For whom'* the intervention would be targeted (e.g., all LTC residents, or a sub-population of residents, such as those with chronic conditions); and

Dimension 3: *'How'* the intervention is expected to effect change.

Intervention 'components' describe the logistical intervention elements that are required for implementation (e.g., increased resources, new technology, tools). The specific research objectives were to answer the following four (4) research questions:

1. Which interventions have been assessed in the literature?
2. Under which *categories* do these interventions fall?
3. What intervention *components* were required to implement these interventions?
4. Which outcome(s) have been measured?

4.4 Methods

4.4.1 Design

This systematic scoping review was conducted as part of a larger published review protocol.[19] It followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist.[20] The process of identification, selection, eligibility, and the inclusion of research articles was reported using The PRISMA 2020 flow diagram for new systematic reviews, which includes searches of databases, registers and other sources.[21] As the research data for this review used publicly available published documents (i.e., and did no collect individual participant data), this study did not require institutional review board approval.

4.4.2 Inclusion criteria

Inclusion and exclusion criteria (Supplemental Table 1) were established following a 2-step iterative pilot test of the preliminary eligibility criteria using a 10% random sample of references retrieved from Medline (Ovid). This process was subsequently repeated on the results obtained from the remaining 11 databases. Experimental and comparative primary observational studies employing quantitative and mixed methods that reported on the impact of interventions on ED transfers and/or hospitalizations from LTC homes were included.

The target LTC home resident population under study pertains to permanent full-time residents aged 18 years and older. Studies were included if they were implemented in a non-community dwelling setting providing a wide range of health and personal care services for persons with medical or physical needs that require access to 24-hour nursing care, personal care and other therapeutic and support services.[22] Any facility that matched this definition was considered to be a LTC home, regardless of the terminology used in the article (e.g., nursing homes, residential aged care facilities, care homes) as variations in facility nomenclature often occur due to geography or intrinsic facility characteristics.[23] Facilities that exclusively provided care to individuals at other points along the healthcare continuum (e.g., respite, rehabilitation, post-acute) were not included within the scope of this review.

Interventions included programs, models of care, or innovations designed to reduce emergency transfers in the event of an acute or complex change in residents' health. Acute care transfer outcome measures included ED transfers and/or hospitalizations. For each study included in our review, intervention outcomes were identified as being either primary or secondary, and whether they were specified as being 'potentially avoidable' or not.

4.4.3 Identification of studies via databases and registers

We searched the following sources from inception until March 2020: 1) Subject heading and textword-based searches: MEDLINE (Ovid), CINAHL, Embase Classic+Embase (Ovid), the Cochrane Library, APA PsycInfo (Ovid); 2) Textword-based searches (Ovid): Social Work Abstracts, AMED (Allied and Complementary Medicine), Global Health, Health and Psychosocial Instruments (HaPI), Joanna Briggs Institute EBP Database, Ovid Healthstar; and 3) Web of Science Core Collection. A research librarian guided our search strategy. The search strategy used for Medline (Ovid) (Supplemental Table 2) was subsequently adjusted for the other data sources. EndNote X9 reference manager,[24] the Covidence systematic review platform,[25] and excel worksheets were used to remove duplicates and to manage the review process. Unpublished trials and comparative observational studies with results were searched within the *ClinicalTrials.gov* registry.[26,27]

4.4.4 Identification of studies via other methods

References cited within the set of articles (reports) deemed eligible for inclusion from our initial searches of databases and registers (i.e., after undergoing full text review) were subsequently reviewed using backward citation tracking.[28] Using the Web of Science citation database, forward citation tracking was conducted to identify relevant new studies that cited this same set of eligible articles. Relevant review articles were tagged throughout the screening process (databases, forward and backward citation tracking), and their cited references were subsequently also screened for relevance. Finally, a grey literature[29] search strategy was performed (Supplemental Table 3) to ensure that our review was comprehensive.[30]

4.4.5 Selection of primary studies

Two peer reviewers (from a pool of five) independently screened each title and abstract retrieved from the database search and then reviewed the full texts of potentially eligible records.

Disagreements between peer reviewers were resolved by consensus[31] and, if needed, the decision was deferred to a third adjudicator. Reports of included studies presenting the same studies/samples were identified, and those with more comprehensive/updated reporting were retained ("Studies included in review").[27] The same selection process was applied to potentially relevant references identified via backward and forward citation tracking. One reviewer performed the selection from the grey literature searches.[30]

4.4.6 Quality appraisal of studies included in the final sample

The Mixed Methods Appraisal Tool (MMAT)[32] was used to assess the quality of our included randomized and nonrandomized studies. Similar to the process used to determine study inclusion, disagreements about quality were resolved through consensus between the two appraisers and discussed with a third adjudicator when they persisted. The MMAT tool encourages reporting each question, but, when needed, it suggests classifying the overall quality as low versus high based on the number of quality items flagged (i.e., at least 4 items would have to be satisfied for a study to qualify as being of 'high' quality).[32] We included all studies in the synthesis regardless of their quality.

4.4.7 Data extraction

After pilot testing and calibrating a preliminary data extraction excel spreadsheet, two independent reviewers extracted the following data from each study: General study information, specifics of the target population under study (i.e., point(s) on the continuum of care and eligibility criteria), text segments of intervention descriptions, intervention participants who were involved with the implementation, outcome measures (i.e., ED transfers, hospitalizations, including potentially avoidable ones). If needed, study corresponding authors were contacted for clarification about their measures, analyses, or unreported endpoints.

4.4.8 Taxonomy development

Our Taxonomy was guided by the concept of person-centered care, which encompasses the needs and expectations of residents/families and respects their right and desire for autonomy, confidentiality, dignity, choice of providers, and prompt/timely care.[33] A hybrid inductive-deductive thematic analysis approach[34] was used.

First, categories were identified inductively using intervention description details provided in each included study. Three dimensions informed the identification and definitions of categories: 1) *'When/ at what point(s)' on the continuum of care'*, based on the dynamic nature of residents/families' needs and expectations over the course of a LTC stay, 2) *'For whom'* the intervention was implemented (i.e., intervention target population and eligibility criteria), and 3) '*How'* the intervention was expected to effect change such that a transition is avoided.

Components were then defined as the set of logistical elements required for intervention implementation that would have the potential to influence outcomes.[35] To qualify as a component, an intervention element had to be distinct, and not comprised of multiple elements. The first author performed the initial development, refined the categories and components in a series of meetings with the senior author, and all authors reviewed and agreed upon the final taxonomy.

Finally, all interventions were mapped to the developed taxonomy based on their categories, components, and outcomes and the results were tabulated. Distributions of components by category and year of publication were presented graphically.

4.5 Results

Figure 4.1 presents the search results. In total, 330 full-texts were reviewed from among 20,859 records identified from database searches and 1,709 records from other searches. Supplemental Table 4 outlines the characteristics of 90 studies included for synthesis. The sample included 25 randomized (including cluster randomized) controlled trials and 65 non-randomized studies. Mixed settings (i.e., where LTC comprised only part of the study population) were identified in 18 studies. Studies were conducted in the USA (34), Australia (20), the UK (10), Canada (8), and other countries (18). Twenty-three studies (26%) were of high quality. The MMAT quality appraisal of included studies is provided in Supplemental Table 5.

Six intervention categories were identified: 'Advance care planning (ACP)', 'Palliative & end-of-life care', 'Onsite care for acute, sub-acute, or uncontrolled chronic conditions', 'Transitional care', 'Enhanced usual care', and 'Comprehensive care'. Due to its unique and specific nature, ACP evolved as a distinct category in our review given that it is a care process that involves multiple components (i.e., 'Tools' and often also 'HR' and 'Training'). Table 4.1 presents the taxonomy of intervention categories and their definitions for each dimension. Four intervention components emerged from the analysis: 'Increasing human resource capacity', 'Training or

reorganization of existing staff', 'Technology', and 'Standardized tools'. For simplicity, these are henceforth shortened to 'Human Resources (HR)', 'Training', 'Technology', and 'Tools', respectively. Table 4.2 presents definitions and examples for each component.

Table 4.3 presents the results of mapping 90 interventions to our proposed taxonomy, with each category stratified by study design (i.e., randomized controlled trials vs. non-randomized studies). Almost one third of all studies fell into the 'Enhanced usual care" category (31%), while 'Onsite care for acute, sub-acute, or uncontrolled chronic conditions' and 'Palliative & end-of-life care' were the next most prevalent intervention categories, representing 18% and 17% of our sample, respectively. Intervention component details for all 90 studies are provided in Supplemental Table 6.

Figure 4.1 PRISMA flow diagram for new systematic reviews which included searches of databases

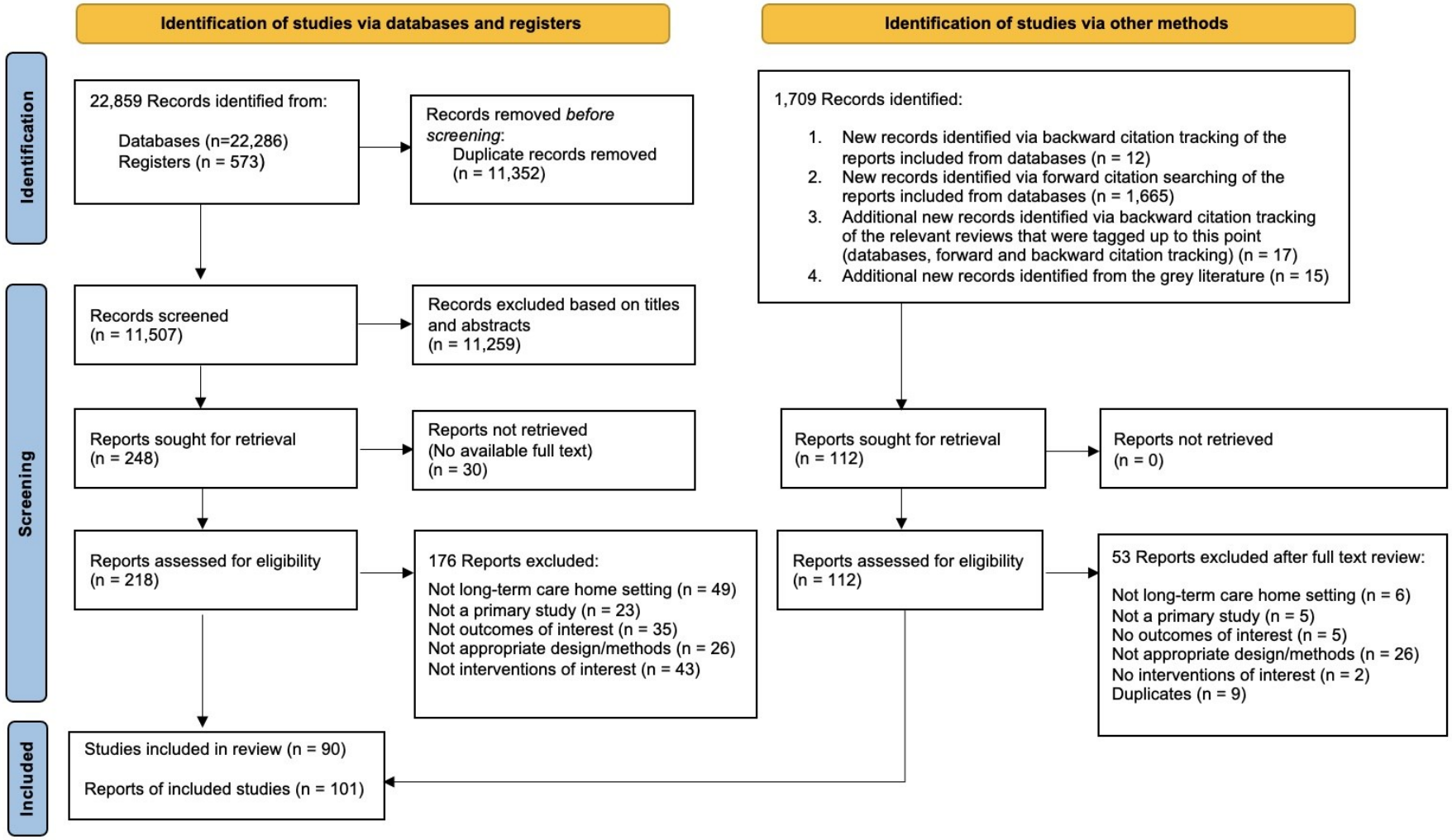


Table 4.1 Taxonomy of intervention categories

CATEGORY	DIMENSION 1: *'When/at what point(s)' on the continuum of care*	DIMENSION 2: *'For whom'*	DIMENSION 3: *'How'*
1 Advance care planning	At all stages of frailty or chronic illness, not just at the end of life	For residents who are: 1) Newly admitted to the LTC home 2) Residing in the LTC home, and therefore may benefit from ACP at regular intervals 3) Observed to have had a change in their health status 4) Experiencing advanced/terminal illness or nearing end of life	By focusing on goals of care to meet a resident's and family's full range of needs (i.e., physical, psychosocial, and spiritual)*
2 Palliative & End-of-life care	When the goal of care decision is established as being palliative & end-of-life care	For residents living with a life-limiting illness that is (usually) at an advanced stage, and for their families	By active provision of comfort and dignity to residents at this life stage, to assist residents and their families attain the best quality of life †
3 Onsite care for acute, subacute, or uncontrolled chronic conditions	When there is a time limited and condition-specific change in residents' health status	For the subset of residents with specific health conditions (e.g., pneumonia, neuropsychiatric symptoms of dementia, chronic obstructive pulmonary disease) or those who have had multiple emergency transfers or hospitalizations	By early identification of and treatment for health conditions onsite, to prevent health deterioration to the point where an emergency department visit is required‡
4 Transitional care	Once the unplanned transfer to acute care decision has been made	For residents for whom the transitional process has begun (i.e., ambulance / emergency paramedics have been called, or residents were sent to the emergency department or have been hospitalized)	By integrating care between LTC home, acute care, and emergency paramedic staff, to reduce gaps in information exchanged between settings and increase the quality of transitional care§
5 Enhanced usual care	Can occur at any time point from admission until palliative/end of life care	For 1) All residents regardless of diagnoses or conditions, or 2) A subset based on time since LTC home admission, or 3) A subset based on eligibility for certain healthcare insurance plans and policies	By implementation of priority-based quality improvements to enhance the quality of usual LTC clinical practices**
6 Comprehensive care	Can occur at any time point from admission until palliative/end of life care	For all LTC home residents regardless of diagnoses, conditions, time since admission, etc.	By incorporating many if not most intervention categories for quality assurance performance improvement††

* Canadian Hospice Palliative Care Association (2021). Essential Conversations. A Guide to Advance Care Planning in Long-Term Care Settings.
† Canadian Hospice Palliative Care Association. "Hospice Palliative Care." Retrieved 8 February 2022, from https://www.chpca.ca/about-hpc/
‡ Canadian Institute for Health Information (2014). Sources of Potentially Avoidable Emergency Department Visits, Ottawa, ON: CIHI.
§ Canadian Institute for Health Information (2009). Patient Pathways: Transfers from Continuing Care to Acute Care. CIHI: Ottawa, Ont.
** Canadian Institute for Health Information. Long-term care homes in Canada: How many and who owns them? Retrieved 2021 Dec. 21, from https://www.cihi.ca/en/long-term-care-homes-in-canada-how-many-and-who-owns-them.
††Ouslander et al. The Interventions to Reduce Acute Care Transfers (INTERACT) quality improvement program: an overview for medical directors and primary care clinicians in long term care. J Am Med Dir Assoc. 2014 Mar;15(3):162-170. doi: 10.1016/j.jamda.2013.12.005

Table 4.2 Intervention components identified via thematic analysis

COMPONENT	DEFINITION	EXAMPLES
Increasing human resource capacity	*"Changes in who provides care, to include the qualifications of who provides care; and the recruitment, distribution and retention of* ***additional*** *health workers"*	- Increasing the number of existing LTC home staff (physicians, nursing and support staff) for specific roles (e.g., technician to assist with telemedicine, provide palliative care) - Adding new expertise (e.g., nurse practitioner, geriatrician, geriatric nurse specialist, specialized nursing expertise). These external personnel may acquire specialized training. - Providing outreach services from various disciplines (e.g., emergency department staff, community pharmacist, wound care team or consultations with specialists) - Research/program personnel to assist with intervention implementation
Training or reorganization of existing staff	*"Educational materials/ meetings,* ***audit/ feedback****, Changes in how* ***existing*** *health workers interact with each other or with* ***residents/families*** *to ensure timely and efficient care delivery"*	- LTC home staff training for clinical skills development to provide enhanced care (e.g., geriatric care, palliative/end-of-life care) or manage residents with specific (physical or mental health) problems - Education to assist residents/families on identifying goals of care (advanced care planning) - Audit and feedback via a summary of health workers' performance over a specified period of time, given to them in a written, electronic or verbal format (e.g., ED transfer/ Hospitalization). The summary may include recommendations for clinical action. - Assigning new innovative roles (e.g., identifying champions) or allocating more time to existing LTC home staff to assist with implementation - Multi/interdisciplinary team meeting implementation among preexisting staff
Technology	*"Information and communication technology to manage delivery of healthcare, or to deliver healthcare"*	- Web-based visual system for telemedicine: direct provision of a clinical service (diagnosis or management) - Technology for diagnostic testing, imaging (e.g., Portable X-ray machine) or treatment - Health information exchange system to facilitate electronic transfer of clinical information or documents or secure messaging - Systems (hardware or software) that alert front-line staff or outreach teams to the status of a resident (e.g., increased mortality risk, etc.)
Standardized tools	***"Tools to guide*** *coordination of care and management of care processes"*	- Clinical assessment and decision-making tools (e.g., care pathways aiming to link evidence to practice for specific health conditions and local arrangements for delivering care. for acute conditions or end-of life care) - Packages of care (practice guidelines or protocols) - Communication tools for use between stakeholders

Definitions were adapted to the long-term care home context from the Effective Practice and Organisation of Care, EPOC Taxonomy; 2015. Our adaptations appear in bold underline font. Available at: https://epoc.cochrane.org/epoc-taxonomy
LTC: Long Term Care

Table 4.3 Interventions mapped to categories and components

Design	Ref.	Target LTC home Resident Population	Intervention	Components					Outcomes		
				HR	Training	Technology	Tools		ED	H	Co
Category 1. Advance Care Planning Interventions											
RCT (n=9)	Brazil 2018	Residents having dementia without decisional capacity to complete an ACP	"Advance Care Planning (ACP) intervention"	✓	✓	--	✓			d	
	Casarett 2005	All permanent residents	"Improving the use of hospice services"	✓	--	--	✓			d	
	Garland 2022	Residents with elevated risk of dying within the next 6–12 months	"Better tArgeting, Better outcomes for frail ELderly patients (BABEL) ACP"	--	✓	--	✓				d
	Hanson 2017	Residents with advanced dementia	"Goals of Care Intervention for Advanced Dementia"	✓	✓	--	✓			d	
	Martin 2019	All permanent residents	"Goals of Patient Care"	✓	--	--	✓		b,d	b,d	
	Mitchell 2020	All long- stay residents (>100 days) enrollment in the Medicare fee- for-service program	"PROVEN Advance Care Planning Video Intervention"	✓	✓	--	✓				b
	Molloy 2000	All residents	"Let Me Decide Advance Care Directive program"	--	✓	--	✓			d	
	Morrison 2005	New residents within 7 days of admission	"Multicomponent ACP"	✓	✓	--	✓			d	
	Overbeek 2019	All residents	"Respecting Choices ACP programme"	--	✓	--	✓		b	b	b
NRS (n=3)	Baron 2015	All residents	"ACP education program"	✓	✓	--	✓			b	
	Caplan 2006	Mentally competent residents as determined by capacity screening	"Let Me Decide Advance Care Directive program"	--	✓	--	✓		b	b	
	O'Sullivan 2016	All residents mostly having cognitive impairment	"Let Me Decide ACP programme"	--	✓	--	✓			b	

Design	Ref.	Target LTC home Resident Population	Intervention	Components					Outcomes		
				HR	Training	Technology	Tools		ED	H	Co
Category 2. Palliative and End-of-Life Care Interventions											
RCT (n=4)	Agar 2017	Residents with advanced dementia	"Facilitated case conferencing on end-of-life care"	✓	✓	--	--		d	d	
	Forbat 2020	Residents at greatest risk of dying without a plan in place and who have a high symptom burden	"Specialist Palliative Care Needs Rounds"	✓	✓	--	--			b,d	
	Kinley 2014	Residents at end of life	"High facilitation + action learning (arm 1) or GSFCH programme (arm 2)"	✓	✓	--	✓			b	
	Temkin-Greener 2018	Medicare beneficiary residents at end of life	"Improve Palliative Care through Teamwork (PCTeams)"	✓	✓	--	✓			b	
NRS (n=11)	Comart 2012	Residents at end of life	"Palliative care consult service"	✓	--	--	--		b	b	
	Finucane 2013	Residents approaching end of life	"Sustainability project of Gold Standards Framework for Care Homes (GSFCH) programme"	✓	✓	✓	✓			b	
	Hockley 2010	Residents at end of life	"GSFCH and an adapted Liverpool Care Pathway for Care Homes"	✓	✓	--	--			b	
	Horey 2012	Residents entering end of life	"Adding end-of-life pathways on the Good Death project"	✓	--	--	✓			**a**,b	
	Levy 2008	Residents at end of life	"Making Advance Planning a Priority Targeting Residents at High Risk of Mortality for Palliative Care"	--	✓	✓	✓			b	
	Livingston 2013	Residents at end of life with dementia	"Interactive staff training program"	✓	✓	--	✓			b	
	Miller 2001	Residents at end of life	"Enrollment in Medicare hospice care"	✓	--	--	--			b	
	Miller 2016a	Residents at end of life	"Palliative care consultations"	✓	✓	--	--			b	
	Miller 2016b	Residents at end of life	"Palliative care consultations"	✓	✓	--	--		b	b	**a**
	Rainsford 2020	Residents approaching at end of life	"Palliative Care Needs Rounds"	✓	✓	--	✓		b	b	
	Teo 2014	Residents at end of life	"Project Care at the End-of-Life for Residents in homes for the Elderly program"	✓	✓	--	--		b	b	

Design	Ref.	Target LTC home Resident Population	Intervention	Components					Outcomes		
				HR	Training	Technology	Tools		ED	H	Co
Category 3. Onsite Care for Acute, Subacute, or Uncontrolled Chronic Conditions Interventions											
RCT (n=6)	Grabowski 2014	Residents necessitating urgent or emergent calls	"Telemedicine"	✓	✓	✓	--			b	
	Lee 2002	Having COPD, at least one hospitalization in previous 6 months	"Care protocol Chronic Obstructive Pulmonary Disease"	✓	✓	✓	--		b	b	
	Loeb 2006	Residents meeting a standardized definition of lower respiratory tract infection	"Clinical pathway for on-site treatment of pneumonia and other Lower Respiratory Tract Infections"	✓	--	✓	✓		b	b	
	Rolland 2020	Without documented dementia, not bedridden, Living in NH at least 1 month Life expectancy >1 year	"Systematic dementia screening, multidisciplinary team"	✓	--	--	✓		b,d	c	
	Romoren 2017	Patients received antibiotics or fluids (for pneumonia, dehydration, etc.)	"Structured training program for health workers"	✓	✓	--	--			b	
	Stern 2014	Residents with Stage II or greater pressure ulcers	"Enhanced multidisciplinary teams"	✓	✓	✓	✓		d	d	
NRS (n=10)	Ashcraft 2017	Residents with multiple comorbidities requiring complex nursing care	"Customized electronic Situation, Background, Assessment, Recommendation communication tool (SBAR)"	✓	✓	✓	✓				b
	Chan 2018	Residents with acute, subacute, end-of-life conditions	"Acute Geriatric Outreach Service (AGOS)"	✓	✓	--	--		d		
	Crilly 2011	Residents with an illness that required hospital services but not necessarily in-hospital admission, could have treatment continued in LTC home	"Hospital in the Nursing Home admission avoidance programme"	✓	✓	--	✓			b	

Design	Ref.	Target LTC home Resident Population	Intervention	Components					Outcomes		
				HR	Training	Technology	Tools		ED	H	Co
	Hutchinson 2015	Residents who are at imminent risk of acute care management (at least one ED attendance or inpatient admission)	"Residential Care Intervention Program in the Elderly (RECIPE)"	✓	--	--	✓		b	b	
	Hutt 2011	Residents with 2 or more signs and symptoms of systemic lower respiratory tract infection	"Multifaceted intervention to implement national consensus guidelines for nursing home–acquired pneumonia"	✓	✓	✓	✓			**a**	
	Lau 2013	Residents with diagnosis: Dehydration, Pneumonia, Urinary Tract Infection, Gastroenteritis, Deep Venous Thrombosis, Terminal care	"Residential Care Intervention Program in The Elderly"	✓	--	--	--			d	
	Lisk 2012	Residents who were admitted to hospital	"Regular liaison of consultant geriatricians with LTC homes"	✓	--	✓	✓			b	
	McCarthy 2020, USA	Long-stay (>100 days) residents who had recently progressed to the advanced stages of dementia, CHF, or COPD	"National initiatives to reduce hospitalizations with Affordable Care Act"	✓	✓	--	✓				**a**,b
	Montalto 2015	Residents required admission to the hospital for nursing home-acquired pneumonia	"Hospital in the Home intervention model"	✓	--	✓	--			b	
	Wills 2018	Residents with and without dementia who sometimes might be "in crisis"	"Community matron Care Home Teams"	✓	✓	--	--		b	b	

Design	Ref.	Target LTC home Resident Population	Intervention	Components					Outcomes		
				HR	Training	Technology	Tools		ED	H	Co
Category 4. Transitional Care Interventions											
RCT (n=1)	Cordato 2018	Permanent residents admitted to the hospital's geriatric service	"Regular Early Assessment Post-Discharge protocol of coordinated care"	✓	--	--	--		b	b	
NRS (n=10)	Brock 2013	Medicare fee-for-service (FFS) insurance Beneficiaries reside in the community for both the index hospitalization and rehospitalization	"Quality Improvement Organizations"	✓	✓	--	✓			d	
	Craswell 2020	All residents who were transferred to the ED	"NP candidate-led service"	✓	✓	✓	--		b	b	
	Fan 2016	Permanent residents who presented to the ED	"Hospital in the Nursing Home program"	✓	✓	--	--		b	b	
	Jensen 2016	Residents with acute illnesses or injuries attended by Extended Care Paramedics or emergency paramedics	"Extended Care Paramedic program"	✓	--	--	--		b	d	
	Marsden 2020	Residents presented to the ED	"Geriatric Emergency Department Intervention"	✓	✓	✓	--		d	b	
	Marshall 2016	Residents with a 911 call	"Care by Design program (CBD)"	✓	✓	--	✓		b		
	McCarthy 2020, Ireland	Residents presented to the ED	"Community Medicine for the Older Person outreach program"	✓	✓	--	--		b	b	
	Shrapnel 2019	Residents presented to the ED	"Mater Aged Care in An Emergency service"	✓	✓	✓	--		b	b	
	Street 2015	Residents presented to the ED	"Residential Care In-Reach"	✓	✓	✓	--		d	b	
	Zafirau 2012	Residents admitted to an inpatient unit from ED	"Advance Directive Transfer Communication Protocol"	✓	✓	--	--			d	

Design	Ref.	Target LTC home Resident Population	Intervention	Components					Outcomes		
				HR	Training	Technology	Tools		ED	H	Co
Category 5. Enhanced Usual Care Interventions											
RCT (n=4)	Arendts 2018	Permanent residents (Life expectancy >180 days)	"Coordinated model of NP/physician care"	✓	✓	--	✓		d	d	
	Boyd 2014	All residents receiving government-funded residential aged care	"The Residential Aged Care Integration Program (RACIP)"	✓	✓	✓	✓			b	
	Cavalieri 1993	Newly admitted to LTCF, having no terminal illness	"Comprehensive Geriatric assessment Team"	✓	--	--	--		b	b	
	Connolly 2015	All residents within all four levels of care	"Aged Residential Care Healthcare Utilisation Study (ARCHUS)"	✓	✓	--	--			**a**,b	
NRS (n=24)	Ackermann 1998	All residents (mostly having dementia)	"Regular transfers by a gerontologist physician assistant"	✓	--	--	--			b	
	Aigner 2004	All residents with a full year follow up	"NP/physician team model"	✓	--	--	--		b	b	
	Burl 1998	Health Maintenance organization residents	"Geriatric NP/physician Program"	✓	--	--	--		b	b	
	Codde 2010	All residents	"An enhanced primary care service for Residential Aged Care Facilities"	✓	✓	✓	--		b	d	
	Connolly 2018	All residents	"Aged Residential Care Healthcare Utilisation Study (ARCHUS)"	✓	✓	--	--		b		
	Gloth III 2011	All residents	"Post-Acute Care Hospitalist Model"	✓	--	--	--		b		
	Graham 2017	All residents	"Responsive Education and Collaborative Health (REaCH) programme"	✓	✓	--	✓		b	b	
	Hex 2015	All residents	"Telemedicine"	✓	--	✓	--		c	c	
	Hullick 2016	All long-stay residents	"Aged Care Emergency service"	✓	✓	✓	✓		b	b	
	Lacny 2016	All residents who were alive	"NP/physician model of care"	✓	--	--	--		b		
	Lloyd 2019	All residents receiving Principia enhanced support or from one of	"Enhanced support intervention"	✓	✓	--	--		b	**a**,b	

Design	Ref.	Target LTC home Resident Population	Intervention	Components					Outcomes		
				HR	Training	Technology	Tools		ED	H	Co
		the 6 comparable local authorities									
	Lukin 2016	All residents	"Hospital in the Nursing Home program"	✓	✓	--	--		b	b	
	Jung 2015	Eligible for MassHealth Standard (i.e., Medicaid)	"Senior Care Options"	✓	--	--	--			b	
	Kane 1989	New admitted or long-stay residents	"Geriatric NPs in LTC home care"	✓	--	--	--		b	b	
	Kane 1991	Medicaid eligible, and eligible for either Part A or Part B of Medicare	"Medicare waiver for NPs and physician assistants to deliver primary care"	✓	--	--	--		b	b	
	Kane 2003	All residents	Evercare: a novel managed care program using NPs"	✓	--	--	--		b	**a**,b	
	Kane 2004	Dual-eligible residents for at least one month in study areas	"Minnesota Senior Health Options (program for dually eligible older persons)	✓	✓	--	--		**a**,b	**a,**b	
	Kumpel 2020	All individuals insured with the Techniker Krankenkasse (Germany's largest HMO)	Additional reimbursement for outpatient physicians treating LTC home residents"	✓	--	--	--			**a**,b	
	Ono 2015	All residents admitted to the LTC home during the study period	"Government designated NP Clinical Trial Practice"	✓	✓	--	--		b	b	
	Reuben 1999	All residents staying in LTC home at least 6 weeks	"Innovative programs for providing primary care for long-stay LTC home residents"	✓	--	--	--		b	b	
	Rolland 2016	All residents staying in LTC home at least 30 days	"Quality improvement initiative on nursing practices and functional decline"	✓	✓	--	✓		b		
	Weatherall 2019	All residents alive during the study period	"Danish Ministry of Social Affairs and Integration Program"	✓	✓	--	--			**a**,b	
	Wieland 1986	All residents	"Academic (Teaching) Nursing Home program"	✓	✓	--					b
	Xing 2016	All residents staying in LTC home at least 90 days and whose care was not exclusively reimbursed by Medicare	"Implementation of Medi-Cal Long-Term Care Reimbursement Act"	✓	--	--	--			**a**	

Design	Ref.	Target LTC home Resident Population	Intervention	Components					Outcomes		
				HR	Training	Technology	Tools		ED	H	Co
Category 6. Comprehensive Care Interventions											
RCT (n=1)	Kane 2017	All residents	"Intervention to Reduce Acute Care Transfers (INTERACT)"	✓	✓	✓	✓		d	**a**,b	
NRS (n=7)	Blackburn 2020	All long-stay residents	"Optimizing Patient Transfers, Impacting Medical Quality, and Improving Symptoms' Care Model"	✓	✓	✓	✓			b	
	Giebel 2020	All residents	"The Care Home Innovation Programme (CHIP)"	✓	✓	✓	✓		**a**	b	
	Ouslander 2011	All residents	"INTERACT"	✓	✓	✓	✓			b	
	Tena-Nelson 2012	All residents	"INTERACT + education and training sessions"	✓	✓	✓	✓			b	
	Vadnais 2020	All long-stay residents	"Enhanced Care and Coordination Providers care improvement models"	✓	✓	✓	✓		**a**,b	**a**,b	**a**,b
	Vogelsmeier 2021	All Medicare/Medicaid long-stay residents	"Missouri Quality Initiative (MOQI)"	✓	✓	✓	✓				b
	Zúñiga 2022	All long stay residents	"Comprehensive, contextually adapted geriatric nurse-led model of care (INTERCARE)"	✓	✓	✓	✓		b		

HR: Human Resources; ED: Emergency Department; H: Hospitalization; Co: Composite; LTC Home: Long-Term Care Home (consolidating reported geographic-specific terminology); PC: Palliative care; EOL: End-of-life; a= potentially avoidable primary; b= other primary; c= potentially avoidable secondary; d= other secondary; Randomized Controlled Studies; NRS: Non-randomized Studies

Figure 4.2 presents the distribution of intervention components by intervention category. In total, 93% of all interventions included an HR component, while 'Training' and 'Tools' (i.e., those usually used in conjunction with training), were the second and third most frequent components, present in 72% and 49% of interventions, respectively. The least frequent component was 'Technology', reported in 30% of intervention studies. The intervention category that more commonly included 'Technology' was 'Onsite care for acute, subacute, or uncontrolled chronic conditions' (50%). 'Technology' was largely absent among 'advanced care planning' (0%) and 'Palliative & end-of-life care' interventions (13%). 'Transitional care' interventions were least likely to include tools as components (18%). All eight 'Comprehensive care' interventions included all four intervention components.

Figure 4.2 Distribution of intervention components by intervention category

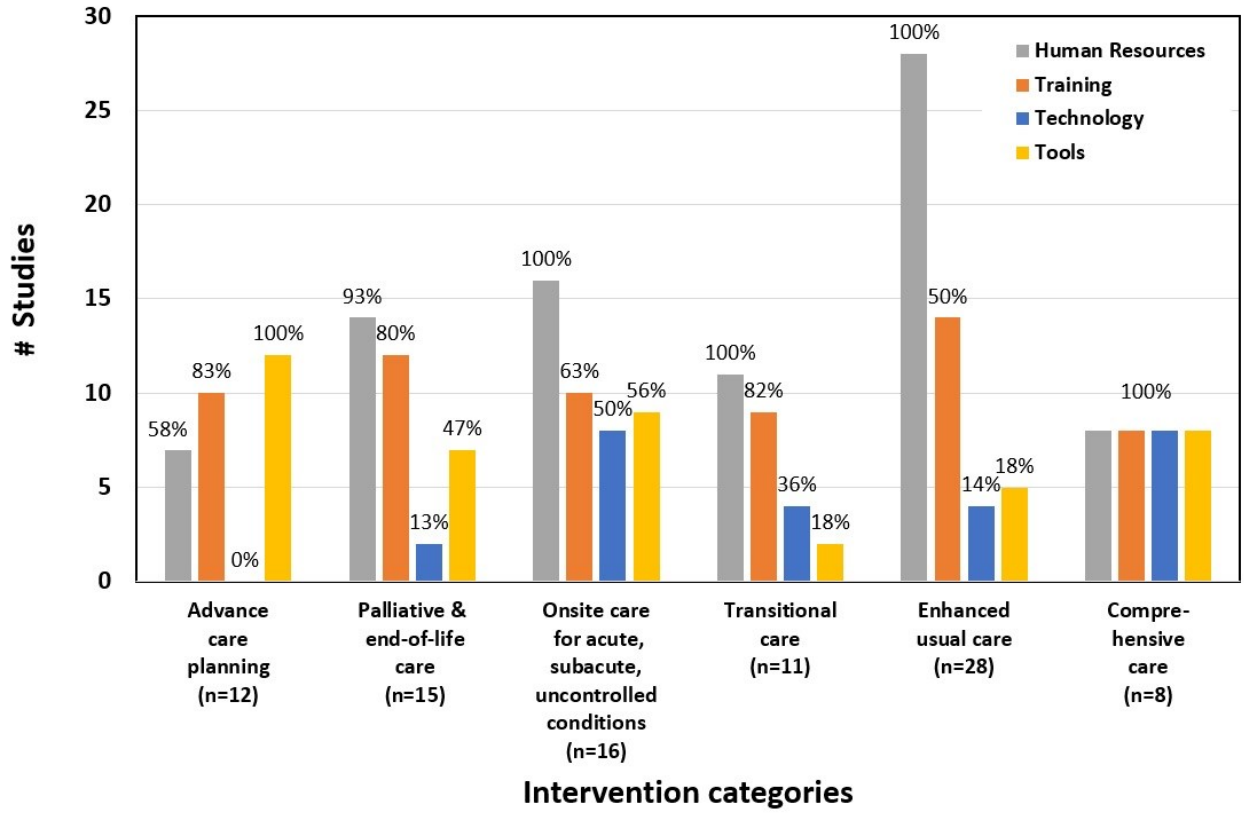
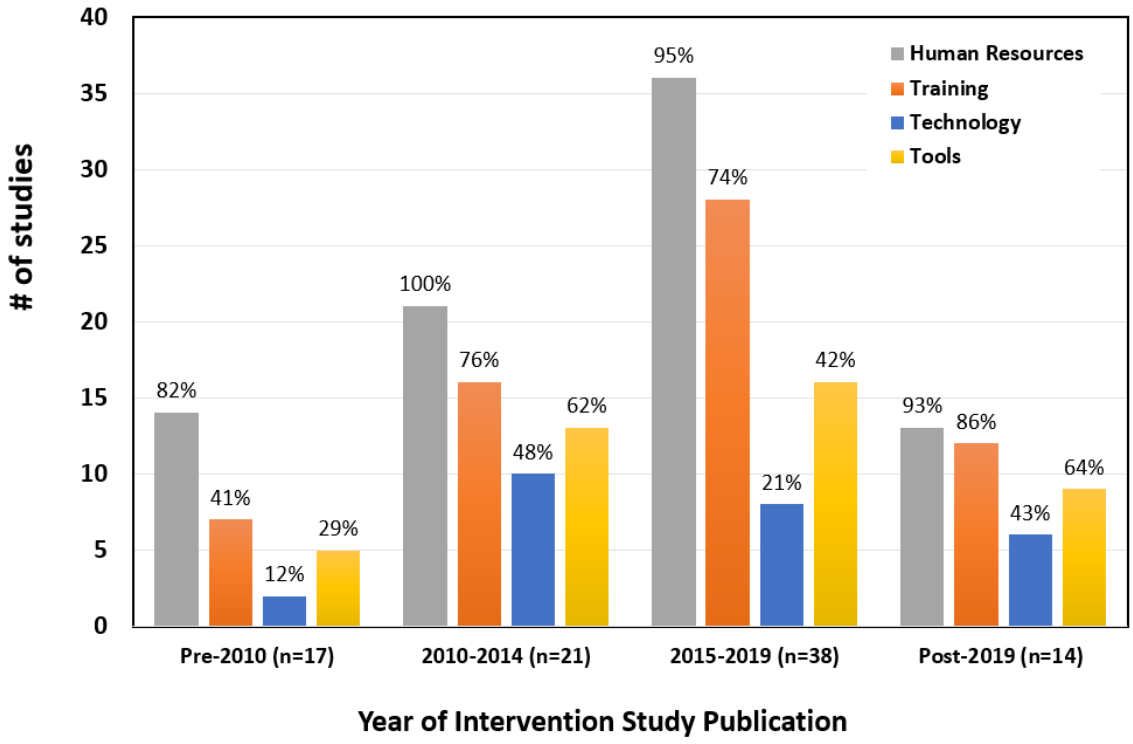


Figure 4.3 illustrates the evolution of component distribution over time. The majority of interventions included an 'HR' component, either alone or in combination with 'Training', which remained stable during the study period. There was a shift among the most recently published interventions (post-2019) that reveal an uptick in increased inclusion of 'Technology' and 'Tools' components as compared with the time period before it (i.e., a 105% and 52% increase, respectively).

Figure 4.3 Distribution of intervention components by study year



Four outcome measure groups emerged: Only ED transfers (8%), only hospitalizations (40%), both ED transfers and hospitalizations (42%), and composite outcomes (10%). Composite outcome measures were reported as varying combinations of ED transfers, hospitalizations, intensive care unit stays, and observation days. Studies measuring potentially avoidable outcomes as their primary outcome were infrequent: 3 studies measured potentially avoidable ED transfers, 11 studies measured potentially avoidable hospitalizations, and 3 studies measured potentially avoidable composite outcomes. Thirteen studies included in the synthesis measured our review outcome measures as secondary outcomes, while 9 studies reported them as both primary and secondary outcomes.

4.6 Discussion

In this systematic scoping review, we first identified all studies that described interventions aimed at reducing acute care transfers from LTC, including those transfers that were considered to be potentially avoidable. We then proposed a taxonomy whereby interventions can be classified as belonging to one of six identified categories and consisting of one or more among four identified components. Given that interventions were typically complex, with the vast majority including multiple and interacting components, this proposed taxonomy can inform future study designs. It will also facilitate future literature reviews that aim to synthesize intervention effectiveness/efficacy via subgroup analysis, thereby increasing confidence in the evidence obtained.

4.7 Six Intervention Categories

'Enhanced usual care', the largest category comprising almost one third of all interventions, targeted either all or newly-admitted residents. This category often included local models of care/programs involving stakeholders at the level of organizations and healthcare systems,[36] such as the addition of geriatric nurse practitioners[37] gerontologist physician assistants,[38] or implementation of a 'Hospital in the Nursing Home program'.[39] It also included interventions arising from policy changes and government-led interventions, such as the Senior Care Options,[40] the Danish Ministry of Social Affairs and Integration Program,[41] the Medi-Cal Long-Term Care Reimbursement Act,[42] or the Medicare waiver allowing nurse practitioner and physician assistants to deliver primary care.[43]

'Advance care planning' addresses the changing needs and expectations of residents and their families throughout their LTC trajectory. These directives are meant to be revised upon admission to LTC, when residents have a change in health status or experience advanced illness, or near the end of life.[44] In cases of advanced dementia, for example, timely ACP updates help facilitate decision-making (e.g., to decline transfer to a hospital when death is imminent). In our synthesis, ACP evolved as a distinct category (and not a component), which appears to be promising in terms of feasibility of implementation from a managerial standpoint, since fewer studies in this category required acquiring additional HR. Our MMAT evaluations, however, indicate that most studies in the ACP category were of poor quality, thereby limiting future evaluation of their overall effectiveness.

'Comprehensive care' interventions were those that, by definition, encompassed all four intervention components and some aspects from other categories. As such, these interventions are the most complex programs usually addressing a multitude of factors (i.e., those related to residents/families, facility characteristics/resources, and local care processes/practices).[36] It is important to note that the 'Comprehensive care' category is distinct from a comprehensive geriatric assessment, the latter of which is a multidimensional and multidisciplinary diagnostic processes focused on determining personalized care plans for older adults. In the LTC setting, residents may indeed benefit from this type of assessment in terms of improved quality of care and reduced hospitalizations,[45] but this is not what is meant by the 'Comprehensive care' category.

While six distinct categories have been proposed, though uncommon, it was also possible that interventions had characteristics that were amenable to more than one category. For example, 4 out of 15 interventions in 'Palliative care & end-of-life care' category also involved discussions about goals of care.[46-49] Similarly, among our 28 'Enhanced usual care' intervention studies, one also incorporated aspects of palliative & end-of-life care[50] and another two included advance care planning.[51,52] In this study, the category that was deemed to be the best match according to the three dimensions of our taxonomy was selected for mapping.

Finally, while most intervention categories had similar distributions of 'HR', and to a smaller extent 'Training', considerable variation was noted with regard to the inclusion of 'Technology' and 'Tools' components by category. As such, there might be an opportunity within a given category to tease out the components that produce the most impact on outcomes via a

component network meta-analysis, which would estimate the relative efficacy of specific components or combinations therein.[53]

4.8 Four Intervention Components

Most interventions required additional 'HR' by appointing supplemental personnel with specific expertise (e.g., geriatrician consultants or geriatric nurse practitioners) or by augmenting their regular composition of front-line staff. Significant heterogeneity in intervention providers (e.g., nurses, physicians, and/or allied healthcare professionals) was previously reported in a systematic review of the efficacy of interventions led by staff with geriatrics expertise in reducing hospitalization in LTC residents.[12] As such, future systematic reviews might report sub-group analyses within a category by 'HR' expertise. 'Training', which can involve assigning existing LTC staff to newly established tasks and roles or implementing new remuneration strategies that allow for more time to perform specific duties (e.g., communication with families), may also be valuable when the inclusion of outside resources is either unavailable or infeasible.

'Technology', the least prevalent component, typically involved: 1) web-based visual systems for telemedicine, 2) tele-coaching for consultations with outside expertise, 3) health information systems implementation, or 4) alert mechanisms. There is some evidence that telemedicine is reliable and effective in achieving glycemic control, reducing medication use, improving medication safety, and in providing needed health care services in general medicine, geriatrics, psychiatry and neurology to LTC residents.[54]

The value of care delivery using technology was underscored in 2020 with the emergence of the COVID-19 pandemic.[55] A paradigm shift towards the use of telemedicine services, particularly with older adults at highest risk of infection and mortality, was observed, and models of care were developed to determine if residents could be treated in the LTC setting or if transfer to the ED was needed.[55] Our results reveal that the proportion of interventions including a technology component doubled post-2019, as compared to the period preceding it. It is worth noting, however, that this finding is conservative, as interventions that were carried out in the year 2020 and beyond may not have been published in time to have been captured by our review.

'ACP' and 'Palliative & end-of-life care' were the two intervention categories that rarely included a 'Technology' component. The Residential Care Transition Module is an example of a psychosocial and psychoeducational telehealth intervention designed to help families successfully

adapt to the LTC admission of a cognitively impaired relative.[56] Our review points to an opportunity that may exist to adapt technologies to future interventions in these categories.

A large number of interventions incorporated 'Tools' aimed at improving processes of care for specific resident care situations. Some tools, for example, targeted assisting staff in managing residents with neuropsychiatric symptoms. In our review, 11 interventions targeted neuropsychiatric symptoms management. The majority were included in the 'Comprehensive care' category, as these interventions assessed the effectiveness of the INTERACT program, which includes an "Evaluation of Medical Causes of New or Worsening Behavioral Symptoms" carepath[57] tool, two were categorized into 'Enhanced usual care"[50,58] and the other two were categorized into the "Onsite care for acute, subacute, or uncontrolled chronic conditions".[59,60]

It is interesting to note that only 18% of 'Transitional Care' interventions included tools as a component. The lack of quality indicators and tools to comprehensively assess the quality of transitions from LTC to the ED and back has been highlighted in the transition literature,[61,62] with a current focus on improving care processes for specific resident conditions, in specific transition settings, as opposed to across the entire transition.[63]

4.9 Methodological Implications regarding Outcome Measures

While the impact of often-complex interventions aimed at reducing ED transfers from the LTC setting has been widely studied, evidence synthesizing their effectiveness has been inconclusive. This is likely due to a multitude of issues, beginning with an inadequate specification of the population, intervention, comparator, and outcome (i.e., 'PICO')[26] under study - the building blocks of any quantitative research question under investigation.

Our proposed taxonomy addresses some of these issues observed in the literature, and our findings suggest two key implications regarding outcome measures used in these (and future) evaluation studies. First, 76 (84%) intervention studies included in this review measured hospitalizations and not ED visits as outcomes. Unlike previous reviews on this subject,[11,12,14,64] we have emphasized the importance of targeting ED transfers irrespective of subsequent hospitalizations, to reflect the fact that the decision to transfer (and not hospitalize) can be modified via interventions at the LTC level, where these interventions are implemented and ultimate decisions regarding transfers are made.

Second, the literature is inconsistent regarding targeting potentially avoidable transfers and all transfers as outcomes, with the latter being more widely represented. In addition, definitions of 'potentially avoidable' transfers or hospitalizations have lacked specificity, in that 'preventable' conditions (e.g., falls, infections, or pressure ulcers) have often not been distinguished from conditions considered to be clinically 'manageable' in the LTC setting (e.g., pneumonia management).[65] For example, one review of interventions reducing hospitalizations from LTC homes included influenza vaccination as a preventative intervention.[15] "Preventing" vs. "managing" acute conditions in the LTC represent distinct focuses, and - in our opinion - should be investigated separately, which is why we have defined "potentially avoidable transfers" as pertaining to "episodes of clinical decline corresponding to specific ACSCs that would more appropriately be managed in the LTC home".[4]

4.10 Strengths and Limitations

This was the first review to propose a taxonomy of interventions aimed at reducing both ED transfers and/or hospitalizations (i.e., including those that are potentially avoidable or not) following an analysis of intervention categories and components that focuses on conditions that are manageable in LTC. We believe that our inductive qualitative synthesis strategy represented the best option given that there was no available appropriate framework for guidance. Although the Effective Practice and Organisation of Care (EPOC) taxonomy of health systems interventions, which classifies interventions into categories based on conceptual or practical similarities within four main domains (i.e., delivery arrangements, financial arrangements, governance arrangements, and implementation strategies), does exist, it focuses on different dimensions of care.[13] In our taxonomy, we opted to focus on dimensions that were directly related to person-centered care, which differentiates ours from the EPOC taxonomy.[13] In doing so, complex and diverse interventions in this field can now be described via relatively homogenous and clinically meaningful categories and components.

This review included both randomized and non-randomized studies to ensure full inclusion of the best available evidence. It also underscores the extent of the clinical heterogeneity present in both individual studies and in previous reviews.[11,14] Although our inclusion criteria limited our analyses to interventions delivered in LTC homes that provide 24-hour nursing care, we did not exclude interventions in mixed settings that can refer to different target populations, but rather

identified them in our Supplemental Table 4. We recommend that future reviews in mixed settings provide subgroup analyses (e.g., of intervention effectiveness) by setting, to assure comparison among clinically homogeneous studies. Although our review inclusion criteria were broad, it is possible that our exclusion of studies not published in either English or French might be an additional limitation. Finally, while we included studies with quantitative outcomes in our review, other relational and qualitative outcome measures, such as resident care satisfaction,[66] family ratings of quality of care for residents,[67] or continuity of care,[68] might be important to consider in future reviews as well.

4.11 Conclusions and implications

We have proposed a taxonomy of interventions aimed at reducing acute care transfers from LTC homes. Our findings have implications for researchers, clinicians, and policy makers. This taxonomy can serve as a tool to improve future study designs and to harmonize outcome measures on this topic. This approach can ultimately assist in reducing the high levels of clinical, methodological, and statistical heterogeneity that currently exists in the literature. Next steps will involve investigating intervention effectiveness or the efficacy of interventions using this proposed taxonomy to allow for the clear identification and evaluation of categories, components, and outcomes. Future work in this area should also focus on synthesizing the impact of interventions aimed at improving the quality of transitional care processes.

4.12 Acknowledgements

4.12.1 Conflict of interest

The authors declare no conflicts of interest.

4.12.2 Author contributions

All authors meet the criteria for authorship stated in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals, and all authors' specific areas of contributions are as follows:
Study concept and design: Deniz Cetin-Sahin, Machelle Wilchesky, Genevieve Gore
Acquisition of data: Deniz Cetin-Sahin, Genevieve Gore, Machelle Wilchesky
Analysis and interpretation of data: Deniz Cetin-Sahin, Machelle Wilchesky, Greta G. Cummings, Isabelle Vedel, Mark Karanofsky, Philippe Voyer, Ovidiu Lungu, Brian Gore
Drafting of the manuscript: Deniz Cetin-Sahin, Machelle Wilchesky

Critical revision of the manuscript for important intellectual content: Greta G. Cummings, Isabelle Vedel, Mark Karanofsky, Genevieve Gore, Philippe Voyer, Brian Gore, Ovidiu Lungu

All authors approved the final version to be published and agreed to be accountable for all aspects of the work.

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4.14 Supplemental Tables & Figures

4.14.1 Supplemental Table 1. Study inclusion/exclusion criteria

Study Characteristics	Inclusion Criteria	Exclusion Criteria
Types of publication	Published primary peer-reviewed articles with data	Books, book reviews, conference proceedings, conference reviews Other non- primary research articles such as review studies* and grey literature (conference abstracts, guidelines, reports, patents, letters, editorials, commentaries, and program descriptions or protocols) †
Language	English or French	Written in another language
Types of interventions	Programs, models of care, innovations, or specific tools designed to reduce emergency transfers in the event of an acute or complex change in residents' health. Can be either intra-facility (with efforts made exclusively by the LTC home and its stakeholders) or inter-facility (with collaboration between the LTC home and other health care settings)	Preventive interventions and programs that aim to reduce the occurrence of acute events that would ultimately result in a reduction in transfers.
Study design and methods	Quantitative and mixed methods experimental [e.g., randomized controlled trials, non-randomized studies, quasi-experimental, or observational studies (e.g., cohort studies, case control studies, or other observational designs)]	Cross-sectional analytic studies at one point in time evaluating the relationship between health-related characteristics (outcome) and other factors (exposure, but not an intervention) Qualitative studies
Population under study	Permanent full-time LTC home residents	If specified, persons younger than 18 years old, patients at these facilities who do not reside full time (e.g., respite care).
Participants (agents of the intervention)	Intervention may involve participants such as residents, physicians, registered nurses, licensed practical nurses, orderlies, other allied health professionals, management staff, administrators, and family members, or other physicians and/or professionals from the community.	Participants younger than 18 years old Studies exclusively involving participants from outside the facility.
Settings	LTC home settings (e.g., 'nursing home', 'residential care', 'care home') Other settings with a long-term care mission that are named otherwise (e.g., Skilled nursing facility, long-term care hospital) Other settings (e.g., ED, hospital, primary care) collaborating with LTC home setting based upon integrated care	Acute care (ED or hospital), respite care or orientation/evaluation (temporary), community-based or home-based settings, or institutions without a long-term care mission with 24-hour nursing care (e.g., Skilled nursing facility as post-acute care only, assisted living facility, rehabilitation services, hospice as a palliative care setting)
Outcome measures	ED transfers and/or hospitalizations (including cost measures if it is possible to derive utilization from these outcomes)	Studies not including at least one of the outcome measures mentioned Cost studies that do not provide unit costs to derive the number of events
*Review studies are tagged, and used for the purposes of backward citation tracking †These are identified, categorized, and included in grey literature review process. More than one publication describing the same study were treated as one study. ED: Emergency Department; LTC: Long-Term Care		

4.14.2 Supplemental Table 2. Database search strategies

MEDLINE (Ovid)
March 27, 2020
Database: Ovid MEDLINE(R) ALL <1946 to March 26, 2020>
Search Strategy:
---
1 exp residential facilities/ (51812)
2 Hospice Care/ (6392)
3 Long-Term Care/ and Workforce/ (593)
4 hospices/ (4975)
5 ((long term care or residential or aged care or extended care or skilled nursing or intermediate care or assisted living or elder care or geriatric care) adj (facilit* or center* or centre* or home* or institution* or unit$1)).mp. (22783)
6 ((long term care or aged care or extended care or nursing or intermediate care or assisted living or elder care or geriatric) adj (residence$1 or resident$1)).mp. (1142)
7 ((old age or nursing or group) adj home*).mp. (47517)
8 care home*.mp. (3869)
9 residential care.mp. (3391)
10 hospice*.mp. (16704)
11 home$1 for the aged.mp. (14439)
12 or/1-11 (89134)
13 Emergency Medical Services/ (42120)
14 emergency medical service communication systems/ (1767)
15 emergency service, hospital/ (66790)
16 emergency medicine/ (13276)
17 emergency nursing/ (7032)
18 acute care.mp. (21407)
19 ((emergenc* adj5 (department* or health* or ward* or service* or unit* or room* or hospital* or care* or patient* or physician* or doctor* or nurse* or nursing or medicine or treatment* or diagnos* or resident*)) or er or ed).mp. (380076)
20 (emergency or emergencies).jw. (99169)
21 or/13-20 (437646)
22 exp Communication/ (302947)
23 exp Telecommunications/ (89755)
24 (phone* or tele* or cellphon* or e mail* or email* or electronic mail* or chat* or convers* or talk* or inform* or checklist* or check list* or interact* or decision* or communicat* or telecommunicat* or tool* or program* or intervention* or assess* or recommend* or improv* or lecture$ or seminar$ or presentation$ or session$ or tutorial$ or education$ or train$ or video$1 or audio or DVD$1 or online or podcast$ or vodcast$ or leaflet$ or manual$1 or book$1 or pamphlet$ or brochure$ or SMS* or text$1 or texting or message$1).mp. (10525158)
25 decision-making/ (93412)
26 (view$1 or viewpoint* or perception$1 or barrier* or facilitator*).mp. (1083640)
27 exp quality of health care/ (6828171)
28 or/22-27 (13978707)
29 exp Interprofessional Relations/ (68621)
30 health facility administration/ (1884)
31 professional-patient relations/ (26778)
32 nurse-patient relations/ (35165)
33 physician-patient relations/ (71811)
34 Professional-Family Relations/ (14666)
35 patient-care team/ (64525)
36 exp patient care management/ (767930)
37 institutional management teams/ (2133)

38 (interprofessional or inter professional or relation$1 or team* or collaborat* or management or manager* or administration* or (physician$1 adj2 nurse$1) or (nurse$1 adj2 famil*) or (nurse$1 adj2 patient$1) or (physician$1 adj2 patient$1)).mp. (4646600)
39 patient transfer/ or transfer*.ti,ab,kw. (636261)
40 or/29-39 (5553853)
41 12 and 21 and (28 or 40) (4207)
42 41 not ((exp infant/ or exp child/ or adolescent/) not exp adult/) (4138)
43 42 not (exp animals/ not humans.sh.) (4138)
44 limit 42 to (english or french) (3930)
45 ("20160707" or "20160708" or "20160709" or 2016071* or 2016072* or 2016073* or 201608* or 201609* or 20161* or 2017* or 2018* or 2019* or 2020*).dt,ez,da. (5443064)
46 44 and 45 (1301)
****

CINAHL Plus with Full Text (EBSCOhost)

March 27, 2020

	Query	Limiters/Expanders	Last Run Via	Results
S51	S49 AND S50	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	1,707
S50	EM 20160707-	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	1,491,318
S49	S47 AND S48	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	6,609
S48	LA english or french	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	7,458,026
S47	S46 NOT ((MH "Child+" OR MH "Adolescence") NOT MH "Adult+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	6,765
S46	S45 NOT (MH "Animals" NOT MH "Humans")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	7,226
S45	S12 AND S26 AND S44	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	7,232
S44	S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	4,890,131

	S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42 OR S43	Search modes - Boolean/Phrase	Search Screen - Advanced Search Database - CINAHL Plus with Full Text	
S43	(interprofessional or "inter professional" OR relation* or team* or collaborat* or management or manager* or administration*) or (physician* N2 nurse*) or (nurse* N2 famil*) or (nurse* N2 patient*) or (physician* N2 patient*) or transfer*	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	1,962,046
S42	(MH "Multidisciplinary Care Team+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	47,788
S41	(MH "Patient Care Plans+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	11,922
S40	(MH "Professional-Family Relations")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	17,611
S39	(MH "Physician-Patient Relations")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	33,955
S38	(MH "Nurse-Patient Relations")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	29,954
S37	(MH "Professional-Patient Relations+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	100,104
S36	(MH "Health Facility Administration+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	22,750
S35	(MH "Interprofessional Relations+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	32,686
S34	(MH "Quality of Health Care+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search	809,727

			Database - CINAHL Plus with Full Text	
S33	view$1 or viewpoint* or perception$1 or barrier* or facilitator*	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	116,972
S32	(MH "Information Science+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	1,647,574
S31	(MH "Decision Making+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	132,710
S30	phone* or tele* or cellphon* or “e mail*” or email* or “electronic mail*” or chat* or convers* or talk* or inform* or checklist* or “check list*” or interact* or decision* or communicat* or telecommunicat* or tool* or program* or intervention* or assess* or recommend* or improv* or lecture* or seminar* or presentation* or session* or tutorial* or education* or train* or video* or audio or DVD* or online or podcast* or vodcast* or leaflet* or manual* or book* or pamphlet* or brochure* or SMS* or text* or message*	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	3,576,025
S29	(MH "Telecommunications+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	139,937
S28	(MH "Communication+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	296,326
S27	(S12 AND S26)	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	7,908
S26	S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	219,980

S25	(emergenc* N5 (department* or health* or ward* or service* or unit* or room* or hospital* or care* or patient* or physician* or doctor* or nurse* or nursing or medicine or treatment* or diagnos* or resident*)) OR er OR ed	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	198,918
S24	"acute care"	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	23,676
S23	(MH "Acute Care Nurse Practitioners")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	464
S22	(MH "Acute Care")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	8,841
S21	(MH "Emergency Nurse Practitioners")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	653
S20	(MH "Physicians, Emergency")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	4,345
S19	(MH "Emergency Patients")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	8,984
S18	(MH "Emergency Nursing")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	15,374
S17	(MH "Emergency Medicine")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	13,946
S16	(MH "Emergency Services, Psychiatric")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	512
S15	(MH "Emergency Service")	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases Search Screen - Advanced Search	56,361

		Search modes - Boolean/Phrase	Database - CINAHL Plus with Full Text	
S14	(MH "Emergency Medical Service Communication Systems")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	2,056
S13	(MH "Emergency Medical Services")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	26,501
S12	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	165,912
S11	"home* for the aged"	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	310
S10	hospice*	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	33,781
S9	"residential care"	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	11,244
S8	"care home*"	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	5,655
S7	("old age" or nursing or group) W1 home*	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	117,823
S6	(“long term care resident” or “aged care resident” or “extended care resident” or “nursing resident” or “intermediate care resident” or “assisted living resident” or “elder care resident” or “geriatric resident” or “long term care residents” or “aged care residents” or “extended care residents” or “nursing residents” or “intermediate care residents” or “assisted living residents” or “elder care residents” or “geriatric	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	1,290

	residents” or “long term care residence” or “aged care residence” or “extended care residence” or “nursing residence” or “intermediate care residence” or “assisted living residence” or “elder care residence” or “geriatric residence” or “long term care residences” or “aged care residences” or “extended care residences” or “nursing residences” or “intermediate care residences” or “assisted living residences” or “elder care residences” or “geriatric residences”)			
S5	"long term care facilit*" or "long term care center*" or "long term care centre*" or "long term care home*" or "long term care institution*" or "long term care unit*" or "residential facili*" or "residential center*" or "residential centre*" or "residential home*" or "residential institution*" or "residential unit*" or "aged care facilit*" or "aged care center*" or "aged care centre*" or "aged care home*" or "aged care institution*" or "aged care unit*" or "extended care facilit*" or "extended care center*" or "extended care centre*" or "extended care home*" or "extended care institution*" or "extended care unit*" or "skilled nursing facilit*" or "skilled nursing center*" or "skilled nursing centre*" or "skilled nursing home*" or "skilled nursing institution*" or "skilled nursing unit*" or "intermediate care facilit*" or "intermediate care center*" or "intermediate care centre*" or "intermediate care home" or "intermediate care institution*" or "intermediate care unit*" or "assisted living facilit*" or "assisted living center*" or "assisted living centre*" or "assisted living home*" or "assisted living institution*" or "assisted living unit*" or "elder care facilit*" or "elder care center*" or "elder care centre*" or "elder care home*" or "elder care institution*" or "elder care unit*" or "geriatric care facilit*" or "geriatric care center*" or "geriatric care	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	19,326

	centre*" or "geriatric care home*" or "geriatric care institution*" or "geriatric care unit*"			
S4	(MH "Hospices")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	3,401
S3	(MH "Long Term Care/NU")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	15
S2	(MH "Hospice Care")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	9,463
S1	(MH "Residential Facilities+")	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text	34,324

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Embase Classic+Embase (Ovid)

March 27, 2020

Database: Embase Classic+Embase <1947 to 2020 March 26>
Search Strategy:
---
1 *assisted living facility/ or *nursing home/ or *residential home/ (29640)
2 *Hospice Care/ (4043)
3 *hospice/ (6055)
4 ((long term care or residential or aged care or extended care or skilled nursing or intermediate care or assisted living or elder care or geriatric care) adj (facilit* or center* or centre* or home* or institution* or unit$1)).tw. (19887)
5 ((long term care or aged care or extended care or nursing or intermediate care or assisted living or elder care or geriatric) adj (resident$1 or residence$1)).tw. (1489)
6 ((old age or nursing or group) adj home*).tw. (40049)
7 care home*.tw. (4856)
8 residential care.tw. (4134)
9 hospice*.tw. (19493)
10 home$1 for the aged.tw. (2135)
11 or/1-10 (96696)
12 *Emergency/ (15391)
13 *Emergency Health Service/ (46719)
14 *emergency ward/ (31116)
15 *emergency medicine/ (27176)
16 *emergency nursing/ (4370)
17 *emergency patient/ (595)
18 *emergency care/ (13564)
19 acute care.mp. (30391)

20 ((emergenc* adj5 (department* or health* or ward* or service* or unit* or room* or hospital* or care* or patient* or physician* or doctor* or nurse* or nursing or medicine or treatment* or diagnos* or resident*)) or er or ed).tw. (468141)
21 (emergency or emergencies).jx. (120771)
22 or/12-21 (589235)
23 exp Interpersonal Communication/ (656415)
24 exp Mass Communication/ (562198)
25 (phone* or tele* or cellphon* or e mail* or email* or electronic mail* or chat* or convers* or talk* or inform* or checklist* or check list* or interact* or decision* or communicat* or telecommunicat* or tool* or program* or intervention* or assess* or recommend* or improv* or lecture$ or seminar$ or presentation$ or session$ or tutorial$ or education$ or train$ or video$1 or audio or DVD$1 or online or podcast$ or vodcast$ or leaflet$ or manual$1 or book$1 or pamphlet$ or brochure$ or SMS* or text$1 or texting or message$1).tw. (13007652)
26 exp decision-making/ (371651)
27 (view$1 or viewpoint* or perception$1 or barrier* or facilitator*).tw. (1181287)
28 health care quality/ (240075)
29 or/23-28 (14098946)
30 nursing home personnel/ (665)
31 doctor-nurse relation/ (5489)
32 hospital management/ or hospital personnel management/ or hospital information system/ or hospital utilization/ or staff training/ or hospital planning/ (92547)
33 nurse-patient relationship/ (34319)
34 doctor-patient relation/ (118374)
35 Professional-Family Relations/ (81733)
36 case management/ or patient care planning/ (41532)
37 management/ or exp hospital management/ or total quality management/ (923411)
38 (interprofessional or inter professional or relation$1 or team* or collaborat* or management or manager* or administration* or (physician$1 adj2 nurse$1) or (nurse$1 adj2 famil*) or (nurse$1 adj2 patient$1) or (physician$1 adj2 patient$1)).tw. (3740698)
39 transfer*.tw. (769456)
40 or/31-39 (5322308)
41 11 and 22 and (29 or 40) (6528)
42 41 not (exp juvenile/ not exp adult/) (6404)
43 42 not (animal/ not human.sh.) (6404)
44 limit 43 to (english or french) (6256)
45 limit 44 to dc=20160707-20200327 (2290)

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Cochrane Library

March 27, 2020

ID Search Hits
#1 MeSH descriptor: [Residential Facilities] explode all trees
#2 MeSH descriptor: [Hospice Care] explode all trees
#3 MeSH descriptor: [Long-Term Care] explode all trees
#4 MeSH descriptor: [Hospices] explode all trees
#5 ("long term care" or residential or "aged care" or "extended care" or "skilled nursing" or "intermediate care" or "assisted living" or "elder care" or "geriatric care") next (facilit* or center* or centre* or home* or institution* or unit?):ti,ab,kw
#6 (("long term care" or "aged care" or "extended care" or nursing or "intermediate care" or "assisted living" or "elder care" or geriatric) next (residence? or resident?)):ti,ab,kw
#7 (("old age" or nursing or group) next home*):ti,ab,kw

#8 care next home*:ti,ab,kw
#9 "residential care":ti,ab,kw
#10 hospice*:ti,ab,kw
#11 ("home for the aged" or "homes for the aged"):ti,ab,kw
#12 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11
#13 MeSH descriptor: [Emergency Medical Services] this term only
#14 MeSH descriptor: [Emergency Medical Service Communication Systems] explode all trees
#15 MeSH descriptor: [Emergency Service, Hospital] this term only
#16 MeSH descriptor: [Emergency Medicine] explode all trees
#17 MeSH descriptor: [Emergency Nursing] explode all trees
#18 "acute care":ti,ab,kw
#19 ((emergenc* near/5 (department* or health* or ward* or service* or unit* or room* or hospital* or care* or patient* or physician* or doctor* or nurse* or nursing or medicine or treatment* or diagnos* or resident*)) or "er" or "ed"):ti,ab,kw
#20 (emergency or emergencies):so
#21 #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20
#22 #12 and #21
#23 MeSH descriptor: [Infant] explode all trees
#24 MeSH descriptor: [Child] explode all trees
#25 MeSH descriptor: [Adolescent] explode all trees
#26 MeSH descriptor: [Adult] explode all trees
#27 (#23 or #24 or #25) not #26
#28 #22 not #27
#29 MeSH descriptor: [Animals] this term only
#30 MeSH descriptor: [Humans] explode all trees
#31 #29 not #30
#32 #28 not #31 in Cochrane Reviews, Cochrane Protocols, Trials

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APA PsycInfo (Ovid)

March 27, 2020

Database: APA PsycInfo <1806 to March Week 4 2020>
Search Strategy:
---
1 residential care institutions/ (10511)
2 nursing homes/ (8489)
3 hospice/ (3198)
4 retirement communities/ (335)
5 group homes/ (1106)
6 ((long term care or residential or aged care or extended care or skilled nursing or intermediate care or assisted living or elder care or geriatric care) adj (facilit* or center* or centre* or home* or institution* or unit$1)).mp. (7355)
7 ((long term care or aged care or extended care or nursing or intermediate care or assisted living or elder care or geriatric) adj (residence$1 or resident$1)).mp. (586)
8 ((old age or nursing or group) adj home*).mp. (15160)
9 care home*.mp. (1869)
10 residential care.mp. (12001)
11 hospice*.mp. (5590)
12 home$1 for the aged.mp. (763)

13 or/1-12 (36104)
14 Emergency Services/ (8217)
15 acute care.mp. (4589)
16 ((emergenc* adj5 (department* or health* or ward* or service* or unit* or room* or hospital* or care* or patient* or physician* or doctor* or nurse* or nursing or medicine or treatment* or diagnos* or resident*)) or er or ed).mp. (44163)
17 or/14-16 (48244)
18 13 and 17 (1042)
19 communication/ or exp electronic communication/ or exp interpersonal communication/ or exp nonverbal communication/ or exp persuasive communication/ or exp verbal communication/ (252145)
20 communication barriers/ (593)
21 exp communication skills/ (21715)
22 communication skills training/ (2249)
23 exp communication systems/ (37841)
24 exp automated information processing/ (4331)
25 exp electronic communication/ (30800)
26 exp information systems/ (46426)
27 exp communications media/ (81001)
28 telemedicine/ (5043)
29 (phone* or tele* or cellphon* or e mail* or email* or electronic mail* or chat* or convers* or talk* or inform* or checklist* or check list* or interact* or decision* or communicat* or telecommunicat* or tool* or program* or intervention* or assess* or recommend* or improv* or lecture$ or seminar$ or presentation$ or session$ or tutorial$ or education$ or train$ or video$1 or audio or DVD$1 or online or podcast$ or vodcast$ or leaflet$ or manual$1 or book$1 or pamphlet$ or brochure$ or SMS* or text$1 or texting or message$1).mp. (3074490)
30 exp decision-making/ (118464)
31 (view$1 or viewpoint* or perception$1 or barrier* or facilitator*).mp. (739602)
32 "quality of care"/ (13120)
33 collaboration/ (10271)
34 Interdisciplinary treatment approach/ (7213)
35 exp health care administration/ (2454)
36 work teams/ (5044)
37 Management/ or case management/ or emergency management/ (17568)
38 (interprofessional or inter professional or relation$1 or team* or collaborat* or management or manager* or administration* or (physician$1 adj2 nurse$1) or (nurse$1 adj2 famil*) or (nurse$1 adj2 patient$1) or (physician$1 adj2 patient$1)).mp. (904018)
39 transfer*.mp. (77277)
40 or/19-39 (3600862)
41 13 and 17 and 40 (912)
42 limit 41 to (100 childhood <birth to age 12 yrs> or 120 neonatal <birth to age 1 mo> or 140 infancy <2 to 23 mo> or 160 preschool age <age 2 to 5 yrs> or 180 school age <age 6 to 12 yrs> or 200 adolescence <age 13 to 17 yrs>) (66)
43 limit 41 to ("300 adulthood <age 18 yrs and older>" or 320 young adulthood <age 18 to 29 yrs> or 340 thirties <age 30 to 39 yrs> or 360 middle age <age 40 to 64 yrs> or "380 aged <age 65 yrs and older>" or "390 very old <age 85 yrs and older>") (612)
44 41 not (42 not 43) (881)
45 limit 44 to (english or french) (846)
46 limit 45 to up=20160707-20200327 (181)

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AMED (Allied and Complementary Medicine), Global Health, Global Health Archive, Health and Psychosocial Instruments (HaPI), Joanna Briggs Institute EBP Database, Ovid Healthstar, Social Work Abstracts (Ovid)

March 27, 2020

Database: AMED (Allied and Complementary Medicine) <1985 to March 2020>, Global Health <1973 to 2020 Week 11>, Global Health Archive <1910 to 1972>, Health and Psychosocial Instruments <1985 to January 2020>, Joanna Briggs Institute EBP Database - <Current to March 18, 2020>, Ovid Healthstar <1966 to February 2020>, Social Work Abstracts <1968 to June 2019>
Search Strategy:
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1 ((long term care or residential or aged care or extended care or skilled nursing or intermediate care or assisted living or elder care or geriatric care) adj (facilit* or center* or centre* or home* or institution* or unit$1)).mp. (29115)
2 ((long term care or aged care or extended care or nursing or intermediate care or assisted living or elder care or geriatric) adj (residence$1 or resident$1)).mp. (1523)
3 ((old age or nursing or group) adj home*).mp. (60772)
4 care home*.mp. (4735)
5 residential care.mp. (4744)
6 hospice*.mp. (21844)
7 home$1 for the aged.mp. (17272)
8 or/1-7 (111981)
9 acute care.mp. (26568)
10 ((emergenc* adj5 (department* or health* or ward* or service* or unit* or room* or hospital* or care* or patient* or physician* or doctor* or nurse* or nursing or medicine or treatment* or diagnos* or resident*)) or er or ed).mp. (347462)
11 or/9-10 (370025)
12 (phone* or tele* or cellphon* or e mail* or email* or electronic mail* or chat* or convers* or talk* or inform* or checklist* or check list* or interact* or decision* or communicat* or telecommunicat* or tool* or program* or intervention* or assess* or recommend* or improv* or lecture$ or seminar$ or presentation$ or session$ or tutorial$ or education$ or train$ or video$1 or audio or DVD$1 or online or podcast$ or vodcast$ or leaflet$ or manual$1 or book$1 or pamphlet$ or brochure$ or SMS* or text$1 or texting or message$1).ti,ab,kw. (8295677)
13 (view$1 or viewpoint* or perception$1 or barrier* or facilitator*).mp. (917433)
14 (interprofessional or inter professional or relation$1 or team* or collaborat* or management or manager* or administration* or (physician$1 adj2 nurse$1) or (nurse$1 adj2 famil*) or (nurse$1 adj2 patient$1) or (physician$1 adj2 patient$1)).mp. (4128168)
15 transfer*.mp. (378578)
16 or/12-15 (10743134)
17 8 and 11 and 16 (4770)
18 limit 17 to (english or french) [Limit not valid in HAPI,Joanna Briggs Institute EBP Database -,SWAB; records were retained] (4562)
19 remove duplicates from 18 (3588)
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Web of Science Core Collection (All Indexes)

March 27, 2020

Set	Results	Save History / Create AlertOpen Saved History	Edit Sets	Combine Sets AND OR Combine	Delete Sets Select All Delete
# 12	534	(#11 AND #6) *AND* **LANGUAGE:** (English OR French) *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years*	Edit		
# 11	25,771,552	#10 OR #9 OR #8 OR #7 *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years*	Edit		
# 10	1,826,045	TS=(transfer*) *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years*	Edit		
# 9	7,412,454	TS=(interprofessional or "inter professional" OR relation* or team* or collaborat* or management or manager* or administration*) or TS=(physician* NEAR/2 nurse*) or TS=(nurse* NEAR/2 famil*) or TS=(nurse* NEAR/2 patient*) or TS=(physician* NEAR/2 patient*) *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years*	Edit		
# 8	2,424,465	TS=(view* or perception* or barrier* or facilitator*) *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years*	Edit		
# 7	20,437,355	TS=(phone* or tele* or cellphon* or “e mail*” or email* or “electronic mail*” or chat* or convers* or talk* or inform* or checklist* or “check list*” or interact* or decision* or communicat* or telecommunicat* or tool* or program* or intervention* or assess* or recommend* or improv* or lecture* or seminar* or presentation* or session* or tutorial* or education* or train* or video* or audio or DVD* or online or podcast* or vodcast* or leaflet* or manual* or book* or pamphlet* or brochure* or SMS* or text* or message*) *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years*	Edit		
# 6	615	#5 AND #4 *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years*	Edit		
# 5	236,185	TS=(emergenc* N5 (department* or health* or ward* or service* or unit* or room* or hospital* or care* or patient* or physician* or doctor* or nurse* or nursing or medicine or treatment* or diagnos* or resident*)) or TS=(er or ed)	Edit		

		Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years		
# 4	70,116	#3 OR #2 OR #1 *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years*	Edit	
# 3	59,100	TS=("old age home" or "nursing home" or "group home" or "old age homes" or "nursing homes" or "group homes" or "care home*" or "residential care" or hospice* or "home for the aged" or "homes for the aged") *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years*	Edit	
# 2	1,254	TS=("long term care resident" or "aged care resident" or "extended care resident" or "nursing resident" or "intermediate care resident" or "assisted living resident" or "elder care resident" or "geriatric resident" or "long term care residents" or "aged care residents" or "extended care residents" or "nursing residents" or "intermediate care residents" or "assisted living residents" or "elder care residents" or "geriatric residents" or "long term care residence" or "aged care residence" or "extended care residence" or "nursing residence" or "intermediate care residence" or "assisted living residence" or "elder care residence" or "geriatric residence" or "long term care residences" or "aged care residences" or "extended care residences" or "nursing residences" or "intermediate care residences" or "assisted living residences" or "elder care residences" or "geriatric residences") *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years*	Edit	
# 1	15,338	TS=("long term care facilit*" or "long term care center*" or "long term care centre*" or "long term care home*" or "long term care institution*" or "long term care unit*" or "residential facili*" or "residential center*" or "residential centre*" or "residential home*" or "residential institution*" or "residential unit*" or "aged care facilit*" or "aged care center*" or "aged care centre*" or "aged care home*" or "aged care institution*" or "aged care unit*" or "extended care facilit*" or "extended care center*" or "extended care centre*" or "extended care home*" or "extended care institution*" or "extended care unit*" or "skilled nursing facilit*" or "skilled nursing center*" or "skilled nursing centre*" or "skilled nursing home*" or "skilled nursing institution*" or "skilled nursing unit*" or "intermediate care facilit*" or "intermediate care center*" or "intermediate care centre*" or "intermediate care home" or "intermediate care institution*" or "intermediate care unit*" or "assisted living facilit*" or "assisted living center*" or "assisted living centre*" or "assisted living home*" or "assisted living institution*" or "assisted living unit*" or "elder care facilit*" or "elder care center*" or "elder care centre*" or "elder care home*" or "elder care institution*" or "elder care unit*" or "geriatric care facilit*" or "geriatric care center*" or "geriatric care centre*" or "geriatric care home*" or "geriatric care institution*" or "geriatric care unit*") *Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI Timespan=All years*		

4.14.3 Supplemental Table 3. Three strategies used to identify potentially relevant grey literature

1. **Unpublished abstracts identified via database searches:** Authors of relevant unpublished abstracts were contacted by e-mail,[1] at which time the goals of the review were briefly explained. Authors were asked about any other relevant published work. If the first author's contact e-mail address could not be found or no response was received, the last author was contacted using the same procedure. If a response was not received within a 14-day period, a reminder email was sent. No further attempts to contact non-responders were conducted beyond this reminder email. All references identified by these authors were considered and retained for further screening. In addition, references without abstracts were hand-searched for further information using McGill University Library resources and Google searches. When available, abstracts, executive summaries, table of contents, and/or websites were screened for relevant published articles.
2. **Google and Google Scholar searches (March 2022):** A simple Boolean search strategy was applied to use the following keywords: intitle:"long term care" OR intitle:residents OR intitle:"nursing homes" intitle:transfers OR intitle:"acute care" tools OR interventions. As suggested by Godin et. al., the first ten pages of each search (representing 100 results) were scanned for potentially relevant titles/text as pages were sorted by relevance, and this corresponded to a feasible number of studies to screen.[2]
3. **Targeted website searches:** My third search strategy involves browsing targeted websites of relevant health organizations and agencies identified through Google and Google Scholar.[2] All websites and search dates were documented, and their names/organizations and URLs were entered into a spreadsheet. Using the website database or website search feature, an iterative 'hand-search' was conducted within each of the relevant website for potentially relevant articles. Websites without a database or search function were hand-searched. Individual records that appeared to be potentially relevant through hand-searching were recorded (name, year, and URL) on the data extraction spreadsheet.

Note: Grey literature is defined as per the widely accepted 'Luxembourg definition', i.e., "information produced on all levels of government, academia, business and industry in electronic and print format not controlled by commercial publishing i.e. where publishing is not the primary activity of the producing body".[3]

References

1. Higgins JPT, López-López JA, Becker BJ, et al. Synthesising quantitative evidence in systematic reviews of complex health interventions. *BMJ Global Health* 2019; 4(Suppl 1): e000858.
2. Godin K, Stapleton J, Kirkpatrick SI, Hanning RM, Leatherdale ST. Applying systematic review search methods to the grey literature: a case study examining guidelines for school-based breakfast programs in Canada. *Systematic Reviews* 2015; 4: 138.
3. Gelfand J. Sixth International Conference on Grey Literature (GL6). *Library Hi Tech News* 2005; 22(1): 20-2.

4.14.4 Supplemental Table 4. Characteristics of studies retained for the synthesis (n= 90)

Author, year	Country	Study design	Intervention Setting	Intervention sample	Control Setting	Control sample
Ackermann 1998[1]	USA	Before after study	A single LTC home†	*Bed capacity: 250*	Same LTC home †	*Bed capacity: 250*
Agar 2017[2]	UK	Cluster RCT	10 LTC homes†	67	10 LTC homes†	64
Aigner 2004[3]	USA	Concurrently controlled retrospective cohort study	8 LTC homes†	Analyzed: I: 102	Same LTC homes†	Analyzed: C: 46
Arendts 2018[4]	Australia	Cluster RCT	3 LTC homes‡	101	3 LTC homes‡	99
Ashcraft 2017[5]	USA	Concurrently controlled prospective cohort study	2 LTC homes† with same Continuing Care Retirement Center management	33 (staff level)	Same LTC homes†	23 (staff level)
Baron 2015[6]	UK	Controlled before-and-after study	9 LTC homes† that had completed the training	Not reported	3 LTC homes† that had yet to undergo the training	Not reported
Blackburn 2020[7,8]	USA	Historically controlled cohort study	19 LTC homes†	Intervention period: 1,460	Same LTC homes†	Pre: 1,434; Ramp-up period: 1,426
Boyd 2014[9]	New Zealand	RCT	29 LTC homes‡ *Rest home (no 24-h nursing care), Private hospital, Dementia care	1,425	25 LTC homes‡*	1,128
Brazil 2018[10]	919	Paired cluster RCT	12 LTC homes† with a dementia nursing category	Analyzed: 51	12 matched LTC homes† by the # of dementia beds	Analyzed: 91
Brock 2013[11]	USA	Controlled before-and-after study	14 communities *Medicare fee-for-service insurance beneficiaries in the community	22,070 beneficiaries	50 communities*	90,843 beneficiaries
Burl 1998[12]	USA	Before after study	45 LTC homes§	414	Same LTC homes§	663
Caplan 2006[13]	Australia	Nonrandomized controlled trial	19 LTC homes† working with 2 hospitals	Not reported	13 LTC homes† working with 1 hospital	Not reported

Author, year	Country	Study design	Intervention Setting	Intervention sample	Control Setting	Control sample
Casarett 2005[14]	USA	RCT	3 LTC homes†	107	Same LTC homes†	98
Cavalieri 1993[15]	USA	RCT	A single LTC‖ that serves as the primary teaching site	33	Same LTC‖	36
Chan 2018[16]	Australia	Historically controlled cohort study	12 LTC homes†	*Bed capacity: 1,325*	Same LTC homes†	*Bed capacity: 1,325*
Codde 2010[17]	Australia	Historically controlled cohort study	A single LTC homes‡ working with a tertiary hospital	Not reported	Same LTC homes‡	Not reported
Comart 2012[18]	USA	Historically controlled cohort study	A single LTC homes§	125	Same LTC homes§	125
Connolly 2015[19,20]	New Zealand	RCT	18 LTC homes‡ *Lower-level 'rest home', higher-dependency 'private hospital', low-level dementia, high-level psychogeriatric	*Bed capacity: 754*	18 LTC homes‡*	*Bed capacity: 607*
Connolly 2018[21]	New Zealand	Controlled before-and-after study	21 LTC homes§ *Same as Connolly 2015	*Bed capacity: 1,258*	*42 non-intervention LTC homes§	*Bed capacity: 1,934*
Cordato 2018[22]	Australia	RCT	21 LTC homes† (19 LTC homes† in final sample) within the hospital catchment area	22	Same LTC homes†	21
Craswell 2020[23]	Australia	Concurrently controlled retrospective cohort study	3 LTC homes** operated by one aged care provider, *One site is high care and all 3 sites had low-care beds	325	*All other LTC homes** presenting to the same public hospital emergency department	1,056
Crilly 2011[24]	Australia	Concurrently controlled retrospective cohort study	42 low- and high-care LTC homes** *Providing nursing-supported care for residents who require assistance	I: 62	Same LTC homes**	115
Fan 2016[25]	Australia	Controlled before-and-after study	LTC homes‡ in the intervention hospital catchment areas	Pre: 2,127 Post: 2,485	LTC homes‡ in the control hospital catchment areas	Pre: 921 Post: 1,313

Author, year	Country	Study design	Intervention Setting	Intervention sample	Control Setting	Control sample
Finucane 2013[26]	UK	Before after study	7 LTC homes††	*Bed capacity: 383*	Same LTC homes††	*Bed capacity: 383*
Forbat 2020[27]	Australia	Stepped-wedge RCT	12 LTC homes††	Full sample: 1,700	Same LTC homes††	Baseline at step 0: 1,089
Garland 2022[28]	Canada	Cluster RCT	15 LTC homes†	271	14 LTC homes†	442
Giebel 2020[29]	England	Before after study	32 LTC homes†† *Including 17 residential homes and 15 LTC homes†	*Bed capacity: 1,314*	Same LTC homes††	*Bed capacity: 1,314*
Gloth III 2011[30]	USA	Controlled before-and-after study	A single LTC home†	390	A single LTC home†	364
Grabowski 2014[31]	USA	RCT	6 LTC homes† *Mixed post-acute and long-stay	*Bed capacity: 177*	5 LTC homes†*	*Bed capacity: 140*
Graham 2017[32]	Ireland	Before after study	Pilot study: 8 LTC homes† to refine the intervention Main study: 20 LTC homes†	Not reported	Same LTC homes†	Not reported
Hanson 2017[33]	USA	Cluster RCT	11 LTC homes†	Pre: 151 Post: 150	11 LTC homes†	Pre: 151 Post: 149
Hex 2015[34]	UK	Controlled before-and-after study	27 LTC homes††	Not reported	21 LTC homes††	Not reported
Hockley 2010[35]	UK	Before after study	7 LTC homes††	Analyzed: Post: 133	Same LTC homes††	Analyzed: Pre: 95
Horey 2012[36]	Australia	Before after study	14 LTC homes‡	*Bed capacity: 1,033*	Same LTC homes‡	*Bed capacity: 1,033*
Hullick 2016[37,38]	Australia	Controlled before-and-after study	4 LTC homes‡	483	8 LTC homes‡	836
Hutchinson 2015[39]	Australia	Interrupted time series	73 LTC homes‡ working with a teaching hospital	1,327	Same LTC homes‡	NA
Hutt 2011[40]	USA	Nonrandomized controlled trial	8 LTC homes†	549	8 LTC homes†	574
Jensen 2016[41]	Canada	Historically controlled cohort study	10 LTC homes§	Post: 224	Same LTC homes§	Pre: 136

Author, year	Country	Study design	Intervention Setting	Intervention sample	Control Setting	Control sample
Jung 2015[42]	USA	Controlled before-and-after study	*Community-dwelling and LTC homes† with Senior Care Options beneficiaries	1,090	*Community-dwelling and LTC homes† with Fee For Service enrollees	22,106
Kane 1989[43,44]	USA	Controlled before-and-after study	30 LTC homes†	New admissions: Pre: 894 Post: 2,189; Long-stay: Pre: 703 Post: 1,068	30 matched LTC homes†	New admissions: Pre: 981 Post: 2,262; Long-stay: Pre: 606 Post: 1,035
Kane 1991[45]	USA	Controlled before-and-after study	75 LTC homes† with Medicare waiver patients *Some return community	1,324	*95 non-participating LTC homes†	1,327
Kane 2003[46,47]	USA	Controlled before-and-after study	44 Evercare-contracted LTC homes†	1,936	Control-In: Same LTC homes† residents who did not enroll Control-out: 44 LTC homes† not participating	Control-In: 1,123 Control-out: 1,745
Kane 2004[48]	USA	Controlled before-and-after study	LTC homes† receiving fee-for-service Medicare and Medicaid managed care *Community dwelling older adults including LTC home† resident	2,136	Control-In: Same LTC homes† residents who did not enroll Control-Out: LTC homes† not participating	Control-In: 3,673 Control-Out: 1,528
Kane 2017[49,50]	USA	Cluster-RCT	88 LTC homes† randomized; Analyzed: 33 LTC homes†	Pre: 9,050 Post: 8,380	176 LTC homes† randomized; Analyzed: 52 LTC homes†	Pre: 14,428 Post: 13,472
Kinley 2014[51]	UK	Cluster RCT	Arm-1: 12 LTC homes† Arm 2: 12 LTC homes†	Arm 1: 804 Arm 2: 703	14 LTC homes†	936
Kumpel 2020[52]	Germany	Controlled before-and-after study	Residents receiving inpatient LTC home† care	18,283	Recipients of professional home care	13,370
Lacny 2016[53]	Canada	Controlled before-and-after study	A single LTC home†	45	Control-in: Same LTC home† A single LTC home† (FP-only model):	Control-in: 65 Control-out: 70

Author, year	Country	Study design	Intervention Setting	Intervention sample	Control Setting	Control sample
Lau 2013[54]	Australia	Historically controlled cohort study	38 LTC homes‡ working with a teaching Hospital providing in-reach care to LTC‡	95	Same LTC homes‡	167
Lee 2002[55]	China	Pair-matched RCT	45 LTC homes† were matched according to previous year number of readmissions	48	Each pair of LTC homes† in the same stratum randomly assigned	41
Levy 2008[56]	Canada	Historically controlled cohort study	A single LTC home†	Post: 45	Same LTC home†	Pre: 27
Lisk 2012[57]	UK	Historically controlled cohort study	Part 1: 3 LTC homes† Part 2: 3 more LTC homes†	Part 1: *Bed capacity: 165* Part 2: Not reported	Same LTC homes†	Part 1: *Bed capacity: 165* Part 2: Not reported
Livingston 2013[58]	UK	Historically controlled cohort study	A single LTC home†	Analyzed: 29	Same LTC home†	Analyzed: 30
Lloyd 2019[59]	England	Concurrently controlled retrospective cohort study	10 LTC homes† *Also 13 residential homes	365 in only LTCs†	27 LTC homes† *Also 13 residential homes	263 in only LTCs†
Loeb 2006[60]	Canada	Cluster RCT	10 LTC homes†	Analyzed: 327	10 LTCs†	Analyzed: 353
Lukin 2016[61]	Australia	Controlled before-and-after study	LTC homes‡ in the catchment areas of Royal Brisbane and Women's Hospital	Pre: 2,127 Post: 2,485	LTCs‡ in the catchment areas of the Logan Hospital	Pre: 921 Post: 1,313
Marsden 2020[62]	Australia	Historically controlled cohort study	ED of a regional hospital where LTC home‡ patients are admitted	Post: 1,458	Same setting	Pre: 1,209 Interim: 3,324
Marshall 2016[63]	Canada	Historically controlled cohort study	10 LTC homes§	Post: 150	Same LTC homes§	Pre: 203
Martin 2019[64]	Australia	Cluster RCT	3 LTC homes‡	Analyzed at 12M: 124	3 LTC homes‡	Analyzed at 12M: 105

Author, year	Country	Study design	Intervention Setting	Intervention sample	Control Setting	Control sample
McCarthy 2020[65]	Ireland	Interrupted time series	LTC homes† within a tertiary acute center catchment (6877 emergency department attendances)	*(Bed capacity: 970 - 1437)*	Same LTC homes†	*(Bed capacity: 970 - 1437)*
McCarthy 2020[66]	USA	Historically controlled cohort study	Federally licensed LTC homes†	Year 2016: 90,306	Same LTC homes†	Year 2011: 35,511
Miller 2001[67]	USA	Concurrently controlled retrospective cohort study	LTC homes† in the Case-Mix Reimbursement and Quality demonstration project	9,202	Same LTC homes†	27,500
Miller 2016a[68,69]	USA	Concurrently controlled retrospective cohort study	170 LTC homes† (159 LTC homes† with data)	Not reported	116 LTC homes† (92 LTC homes† with data)	Not reported
Miller 2016b[70]	USA	Concurrently controlled retrospective cohort study	46 LTC homes†	477	Same LTC homes†	1,174 (1:3 propensity score matched)
Mitchell 2020[71]	USA	Cluster RCT	119 LTC homes†	With advanced illness: 4,171; without advanced illness: 5,764	241 LTC homes†	Advanced illness: 8,308; No advanced illness: 11,773
Molloy 2000[72]	Canada	RCT	3 LTC homes†	527	3 matched control LTC homes†	606
Montalto 2015[73]	Australia	Case control study	30 high-level LTC homes‡ and a hospital	60	Same LTC homes‡	54
Morrison 2005[74]	USA	RCT	A single LTC home‖	43	Same LTC home‖	96
Ono 2015[75]	Japan	Historically controlled cohort study	A single LTC home† *Both long-term and short-term beds	Post: 219	Same LTC home†	Pre: 260
O'Sullivan 2016[76]	Ireland	Historically controlled cohort study	3 LTC homes§	Post: 301	Same LTC homes§	Pre: 287
Ouslander 2011[77]	USA	Controlled before-and-after study	25 LTC homes†	Not reported	11 matched control LTC homes†	Not reported

Author, year	Country	Study design	Intervention Setting	Intervention sample	Control Setting	Control sample
Overbeek 2019[78]	Netherlands	Cluster RCT	16 residential LTC homes†† *Both residential and home care	Analyzed: 97	*16 residential LTC homes††	Analyzed: 97
Rainsford 2020[79]	Australia	Historically controlled cohort study	2 LTC homes‡ in a rural town *High-level care, 24-h RN onsite, and low-level care to age in place and had a nurse on-call overnight	43	*2 LTC homes‡ in a rural town	113
Reuben 1999[80]	USA	Concurrently controlled retrospective cohort study	20 LTC homes†	Plan A: 85 Plan B: 75 Plan C: 55	Same LTC homes†, Fee-for service residents	Plan A: 56 Plan B: 71 Plan C: 60
Rolland 2016[81]	France	Nonrandomized controlled trial	85 LTC homes†	2,652 analyzed at 18 months including 830 newly selected	90 LTC homes†	3,085 analyzed at 18 months including 934 newly selected
Rolland 2020[82]	France	Cluster RCT	32 LTC homes†	Analyzed: 599	32 LTC homes†	Analyzed: 829
Romoren 2017[83]	UK	Pragmatic cluster stepped-wedge RCT	30 LTC homes†: 9 large, 21 small *Rehabilitation, short term and long-term care, palliative care, dementia departments	Analyzed: 228	Same LTCs†	102
Shrapnel 2019[84]	Australia	Historically controlled cohort study	90 LTC homes** in the hospital's catchment zone	391	Same LTC homes**	730
Stern 2014[85]	Canada	Pragmatic cluster stepped-wedge RCT	12 LTF homes§	Not reported	Same LTF homes§	Not reported
Street 2015[86]	Australia	Historically controlled cohort study	All LTC homes‡ and 3 EDs at one major health service	Post: 2,051	Same LTC homes‡	Pre: 2,278
Temkin-Greener 2018[87]	USA	RCT	14 LTC homes†	94	11 Non-randomized LTC homes† All 609 non-intervention LTC homes† in the state	67

Author, year	Country	Study design	Intervention Setting	Intervention sample	Control Setting	Control sample
Tena-Nelson 2012[88]	USA	Historically controlled cohort study	18 LTC homes† with complete data	*Average bed capacity: 377*	Same LTC homes†	*Average bed capacity: 377*
Teo 2014[89]	Singapore	Concurrently controlled retrospective cohort study	7 LTC homes†	48	Same LTC homes†	197
Vadnais 2020[90,91]	USA	Controlled before-and-after study	15-30 LTC homes† in 7 states with varying models	Pre: 24,978 Post: 67,315	Matched long-stay LTC homes†	Pre: 41,986 Post: 117,383
Weatherall 2019[92]	Denmark	Controlled interrupted time series	7 LTC homes†	Analyzed: 338	783 LTC homes†	Analyzed: 26,466
Wieland 1986[93]	USA	Concurrently controlled prospective cohort study	A single academic LTC home†	60	Same LTC home† comparison wards	91
Wills 2018[94]	England	Historically controlled cohort study	*35 residential and LTC homes†	Not reported	Same LTC homes†	Not reported
Xing 2016[95]	USA	Interrupted time series	1,187 LTC homes†	329,074	Same LTC homes†	Not reported
Vogelsmeier. 2021[96-99]	USA	Interrupted time series	16 LTC homes	Average # of eligible residents/month= 1819 in 2014 to 1068 in 2019	Same LTC homes†	Same sample
Zafirau 2012[100]	USA	Historically controlled cohort study	26 LTC homes§ and one ED	Analyzed: 117	Same LTC homes§	Analyzed: 130
Zúñiga, 2022[101]	Switzerland	Nonrandomized stepped-wedge design	11 LTC homes†	Full sample: 942	Same LTC homes†	NA

In the 'Author, year' column, the first citation is primary article, others are duplicates of the same study/sample. Study designs were harmonized using the checklist proposed by Reeves et al. 2017 (DOI: 10.1016/j.jclinepi.2017.02.016). RCT: Randomized Controlled Trial. In setting columns, Long-Term Care (LTC) Home (consolidating reported geographic-specific terminology), and * indicates mixed settings which may include home-based care, primary care, acute care. Original setting terms used in studies were indicated: †Nursing Home, ‡Residential Aged Care Facility, §Long-Term Care Facility, ||Skilled Nursing Facility, **Aged Care Facility, ††Care home.

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4.14.5 Supplemental Table 5. Quality of studies using Mixed Methods Appraisal Tool

Notes: ✓: 'Yes'; − : 'No'; Blank: 'Can't tell'

A. Randomized Controlled Trials						
Category, Author, Year, Country	**Is randomization appropriately performed?**	**Are the groups comparable at baseline?**	**Are there complete outcome data?†**	**Are outcome assessors blinded to the intervention provided?**	**Did the participants adhere to the assigned intervention?**	**Overall Score**
Category 1. Advance Care Planning Interventions						
Brazil, 2018, UK	✓			−	−	*
Casarett, 2005, USA	✓	✓	✓		−	***
Garland, 2022, Canada	✓	−	✓		−	**
Hanson, 2017, USA	✓	✓	✓	✓	✓	*****
Martin, 2019, Australia	✓	✓	✓	−		***
Mitchell, 2020, USA	✓	✓	✓	✓	−	****
Molloy, 2000, Canada		✓	✓		✓	***
Morrison, 2005, USA		−	✓		−	*
Overbeek, 2019, The Netherlands		✓	✓			**
Category 2. Palliative and End-of-Life Care Interventions						
Agar, 2017, UK	✓	✓		✓	−	***
Forbat 2020, Australia	✓		✓	−	−	**
Kinley, 2014, UK*	✓	✓	✓		−	***
Temkin−Greener, 2018, USA*	✓	−	✓		−	**
Category 3. Onsite Care for Acute, Subacute, or Uncontrolled Chronic Conditions Interventions						
Grabowski, 2014, USA		✓	✓		−	**
Lee, 2002, China		✓	✓			**
Loeb, 2006, Canada	✓	✓	✓	−	✓	****
Rolland, 2020, France	✓	✓	✓	−		***
Romoren, 2017, United Kingdom	✓	−	✓			**
Stern, 2014, Canada*	✓	✓	✓	✓	−	****

Category 4. Transitional Care Interventions						
Cordato, 2018, Australia	✓	–	✓	✓	✓	****
Category 5. Enhanced Usual Care Interventions						
Arendts 2018, Australia	–	✓		✓	–	**
Boyd, 2014, New Zealand	✓	✓	✓	–		***
Cavalieri, 1993, USA		✓				*
Connolly, 2015, New Zealand	✓	✓	✓			***
Category 6. Comprehensive Care Interventions						
Kane 2017, USA	✓	✓	✓		–	***

B. Non−Randomized Studies						
Author, Year, Country	**Are the participants representative of the target population?**	**Are measurements appropriate regarding both the outcome and intervention (or exposure)?**	**Are there complete outcome data?†**	**Are the confounders accounted for in the design and analysis?**	**During the study period, is the intervention administered (or exposure occurred) as intended?**	**Overall Score**
Category 1. Advance Care Planning Interventions						
Baron, 2015, UK	✓	–	✓	–		**
Caplan, 2006, Australia	✓	–			✓	**
O'Sullivan, 2016, Ireland	✓	✓	✓	–	✓	****
Category 2. Palliative and End-of-Life Care Interventions						
Comart, 2012, USA	–	✓	✓	✓	✓	****
Finucane, 2013, UK		✓			–	*
Hockley, 2010	✓	✓	✓		–	***
Horey, 2012, Australia*	✓	✓			–	**
Levy, 2008, Canada	✓		✓	✓		***
Livingston, 2013, UK*	✓			–		*
Miller, 2001, USA	✓	–	✓	✓		***
Miller, 2016a, USA	✓	✓		✓		***
Miller, 2016b, USA	✓	✓		✓		***

Rainsford, 2020, Australia	✓	✓		✓	–	***
Teo, 2014, Singapore	✓	✓		✓		***
Category 3. Onsite Care for Acute, Subacute, or Uncontrolled Chronic Conditions Interventions						
Ashcraft, 2017, USA*		✓		–	–	*
Chan, 2018, Australia	✓	✓	✓	–	–	***
Crilly, 2011, Australia	✓	–	✓	✓	–	***
Hutchinson, 2015, Australia	✓	✓	✓	✓		****
Hutt, 2011, USA*	✓	✓	✓	✓	–	****
Lau, 2013, Australia	✓	–	✓	✓		***
Lisk, 2012, UK	✓	✓	✓			***
McCarthy 2020, USA	✓	✓		✓		***
Montalto, 2015, Australia	✓	–	✓	✓	–	***
Wills, 2018, England		✓				*
Category 4. Transitional Care Interventions						
Brock, 2013, USA	✓	–	✓	✓		***
Craswell, 2020, Australia	✓	✓		–		**
Fan, 2016, Australia	✓	✓	✓	✓		****
Jensen, 2016, Canada	✓		✓	–		**
Marsden, 2020, Australia	✓	–	✓	✓		***
Marshall, 2016, Canada	✓	✓	✓	✓	–	****
McCarthy, 2020, Ireland	✓	✓	✓	–		***
Shrapnel, 2019, Australia	✓	✓	✓	–		***
Street, 2015, Australia	✓	✓				**
Zafirau , 2012, USA	✓	✓			–	**
Category 5. Enhanced Usual Care Interventions						
Ackermann, 1998, USA	✓	–		–	✓	**
Aigner, 2004, USA	✓	✓	✓		✓	****
Burl, 1998, USA		–		✓	✓	***
Codde, 2010, Australia*		✓		✓		**
Connolly, 2018, New Zealand	✓	✓	✓	✓	✓	*****
Gloth III, 2011, USA		–	✓	✓		**
Graham, 2017, Ireland		✓	✓			**

Hex, 2015, UK		✓	✓		–	**
Hullick, 2016, Australia	✓	✓	✓	✓		****
Lacny, 2016, Canada	✓	✓	✓	✓	–	****
Lloyd, 2019, England	✓	✓		✓		***
Lukin, 2016, Australia	✓	✓	✓	✓		****
Jung, 2015, USA	✓	✓	✓	✓		****
Kane, 1989, USA	✓	✓	✓	✓		****
Kane, 1991, USA	✓	✓		✓		***
Kane, 2003, USA	✓	✓	✓	✓		****
Kane, 2004, USA	✓	✓		✓		***
Kumpel, 2020, Germany	✓	–		✓		**
Ono, 2015, Japan	✓	✓	✓	–		***
Reuben, 1999, USA*	✓	✓	✓	✓	–	****
Rolland, 2016, France	✓	✓		✓	✓	****
Weatherall, 2019, Denmark	✓	✓	✓	✓		****
Wieland, 1986, USA	✓	✓				**
Xing, 2016, USA	✓	✓		✓		***
Category 6. Comprehensive Care Interventions						
Blackburn, 2020, USA	✓	✓	✓	–	–	***
Giebel, 2020, England		✓		–	✓	**
Ouslander, 2011, USA		✓	✓	✓		***
Tena−Nelson, 2012, USA		✓		–		*
Vadnais, 2020, USA	✓	✓		✓		***
Vogelsmeier 2021, USA	✓	✓	–	✓	–	***
Zúñiga, 2022, Switzerland	✓	✓	✓	✓		****

*In mixed-methods studies, only quantitative component of the appraisal tool was presented as per the aim of the study.
†Given the typically high turnover rate in long−term care, we expect many losses to follow−up. Rates of up to 40% or higher may be expected.

4.14.6 Supplemental Table 6. Details of intervention components from identified studies

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
Category 1. Advance Care Planning Interventions					
RCT (n=8)	Brazil 2018	ACP facilitator (RN with 2 years' experience in palliative care, completed online training programs)	Training provided to site staff and physicians. Family education	--	Booklet: 'Comfort care at the end of life for persons with Dementia'
	Casarett 2005	Clinical Research Assistants*	--	--	Scripted interview questions to assess the resident's appropriateness for hospice care
	Garland 2022	--	Orientation and training provided to site staff, online materials provided, structured training (~60-min discussion) between a resident, substitute decision-maker and staff	--	Workbook to guide ACP discussions; Online tools for stakeholders: Care Recommendations from the Coalition for Compassionate Care
	Hanson 2017	Investigators*	Training for site staff about creating care plans	--	Goals of Care Video guide included questions to consider in care planning to help decisions
	Martin 2019	Geriatrician led process of identifying goals of care	--	--	'Goals of Patient Care' form
	Mitchell 2020	A dedicated senior project manager* was employed in each site (partnered with the ACP champions for planning, training, and implementation)	1-month training (webinar or in person) for 2 ACP program champions (usually social workers) who educated patients and families about general goals of care, goals of care for advanced dementia, hospice, hospitalization, and ACP via 5 videos.	--	Printed toolkits; pocket-sized guides

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
	Molloy 2000	--	Workshop for RNs on healthcare facilitation; Site staff, residents, and families received training about advance directives	--	The Let Me Decide advance directive document
	Morrison 2005	Intervention social workers provided structured ACP discussions and reviewing goals of care	Half-day ACP training for the intervention social worker	--	ACP document
	Overbeek 2019	--	NP participated in a train-the-trainer programme, and then trained 8 RNs Information leaflets used.	--	Power of Attorney for Healthcare Document; Scripted interview cards
NRS (n=3)	Baron 2015	ACP facilitator	ACP training workshops for site staff	--	ACP document
	Caplan 2006	--	Education for residents, their families, staff and physicians about the terminal nature of dementia, ACP, and hospital in the home (the latter was implemented at both intervention and control sites)	--	A written, legally binding Advance Care Directive document that express preferences for future medical treatment
	O'Sullivan 2016	--	Workshops on the programme and palliative care; Educational resources for residents and families	--	Screening instrument to assess capacity to complete an Advanced Directive; Implementation manual for policy on completing ACP; decision aids; documentation templates

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
Category 2. Palliative and End-of-Life Care Interventions					
RCT (n=4)	Agar 2017	Palliative Care Planning Coordinator (a trained RN per site 2 days/week organized case conferences with families and multi-disciplinary meetings with site staff and physicians)	Palliative care training provided to site staff	--	--
	Forbat 2020	Trial clinicians (based in the city's specialist Palliative Care unit to advise 2 NPs and a clinical nurse consultant)	Staff briefing regarding aims and practicalities of the model of care; discussions with the resident, physician, and site staff for completion of ACP	--	--
	Kinley 2014	CNS/Gold Standards Framework for Care Homes (GSFCH) facilitator	2 coordinators were appointed per site. 4-day training provided.	--	Liverpool Care Pathway: An integrated care pathway protocol
	Temkin-Greener 2018	Geriatric NP implemented facility-based palliative care teams (5 to 12 staff members)	1-hour palliative and end-of-life training for site staff; Online training modules	--	TeamSTEPPS: Strategies & Tools to Enhance Performance and Patient Safety
NRS (n=11)	Comart 2012	Interdisciplinary palliative care team identifying residents' goals of care	--	--	--
	Finucane 2013	Two community palliative care clinical nurse specialists provided 7.5 h of support per site per month	The nurse specialist provided training including first principles of care, communication skills development, pain and symptom management, and bereavement; Monthly meetings where the nurse specialists discussed the palliative care register with site staff, and physicians and supported site staff in assessing the prognosis of a resident.	Teleconsultations‡ between a nurse specialist and site staff	A supportive/palliative care register: It helped classifying each resident according to prognosis. A prognostic indicator of 'A' reflects a resident who is expected to live for more than a year, 'B' reflects a prognosis of months, 'C' reflects weeks and 'D' reflects days.
	Hockley 2010	An experienced palliative care nurse facilitator worked with 2 appointed site key champions to coordinated changes	4-day training + 4 workshops provided over the year to key champions who then trained onsite staff.	--	--

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
	Horey 2012	2 General Practice divisions, pharmacists, specialists, and research staff*	--	--	End-of-life care pathway which could be initiated by a physician or a RN; Care management, daily comfort care chart and further care action sheet; Multidisciplinary communication sheet
	Levy 2008	--	Training for social work and palliative care consultants about the advance directive tool; Site physician time was allocated to in-depth conversations about end-of-life care preferences	Report indicating residents with high mortality risk faxed to the physician weekly	Mortality prediction tool; 'Nursing Homes and Life-sustaining Options for Treatment' tool; Advance directive tool
	Livingston 2013	Physician consultant*	Senior site managers (trained in Gold Standard Framework) first received and then provided 10 training sessions to site staff on end-of-life care, challenges of dementia, dementia physical process and symptom, emotional and psychological needs, planning, religion/spirituality, and holistic care	--	A form designed to be filled in by the staff about relatives' decisions regarding advanced wishes including emergency care plans
	Miller 2001	External hospice providers contracted	--	--	--
	Miller 2016a	NPs with extensive palliative care training	NPs consulted with staff	--	--
	Miller 2016b	NPs under the supervision of certified palliative care physicians	Palliative consultations, family meetings and discussion of goals of care	--	--
	Rainsford 2020	A palliative medicine physician led 'Needs Rounds' for site staff	Case-based education and staff support provided	--	Palliative Care Checklist
	Teo 2014	A team of specialist practice nurses, supported by a geriatrician	Training to improve geriatric patient assessment and management skills for site staff	--	--

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
Category 3. Onsite Care for Acute, Subacute, or Uncontrolled Chronic Conditions Interventions					
RCT (n=6)	Grabowski 2014	1 medical secretary, a RN, a NP, and a physician to cover urgent or emergent calls on weeknights and weekend days	Training sessions on how to use the telemedicine system	Telemedicine§: Equipment for two-way videoconferencing and high-resolution camera for use in wound care	--
	Lee 2002	A trained community nurse conducted comprehensive resident assessments, produced the care plan, and provided support for transfer decisions. A GNS visited the patient within 24 hours of hospital admission and again upon return to the LTC home	3-day training for community nurses about care of older patients with COPD; Community nurses provided training to site staff about appropriate care after hospital discharge and to residents and appropriate care procedures (e.g., drug and diet regime, breathing exercise, use of inhalers)	Teleconsultations between the GNS and site staff	--
	Loeb 2006	Study nurses* clinically assessed residents who met a standardized definition of lower respiratory tract infection according to the study protocol	--	Chest radiographs performed on site by a mobile unit within 12 hours of enrollment	Clinical Pathway for on-site treatment of pneumonia and other lower respiratory tract infections
	Rolland 2020	A coordinating physician conducted comprehensive geriatric assessments + led multidisciplinary team meetings	--	--	Dementia screening tool
	Romoren 2017	Two hospital nurses with experience in older adult intravenous treatments ran the training program	1-day training session to site staff (prevention, presentation, diagnosis and intravenous treatment of dehydration and infections, and practical training). Simulation Centre at the hospital provided practical training	--	--
	Stern 2014	An advance practice nurse with expertise in skin and wound care	Training to site staff pressure ulcer treatment and prevention.	Teleconsultations with wound care team and site staff via email, telephone, or video link	Evidence-based guidelines: Registered Nurses' Association of Ontario

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
NRS (n=10)	Ashcraft 2017	4 clinicians (physicians, NPs, and PAs who care for LTC home residents at least once a week) IT support for clinical record placement.	1-hour orientation provided to nurses on when and how to use the customized Situation, Background, Assessment, Recommendation (SBARc) tool	The tool was embedded in the onsite electronic health record and was accessible to RNs to use as part of routine documentation	Customized electronic SBAR tool to communicate changes in condition
	Chan 2018	Two part-time geriatricians (each 0.5 full time equivalent, weekdays, 9 am to 5 pm) and a nurse were employed to assist with acute (e.g., infections requiring IV treatment, delirium), subacute (management of behavioural and psychological symptoms of dementia), end-of-life situations	Site staff training provided	--	--
	Crilly 2011	1 RN program manager, ED director, general practitioners and nurses to deliver acute care services onsite after return to LTC home from the ED	Training and consultation provided to site clinical staff regarding antibiotic or intravenous fluid administration; specific wound treatment and dressing; suprapubic catheter care, behaviour management and palliative care.	--	Protocols and pathways for acute care
	Hutchinson 2015	Geriatrician-led multidisciplinary team + GNS referred to palliative and other allied health clinicians	--	--	Written advanced directive form
	Hutt 2011	Multidisciplinary research team including 3 study pharmacists with geriatric expertise and infectious disease and a geriatrician principal investigator*	1 RN (study liaison) acted as the change agent. Multidisciplinary meetings with the medical director, physicians, NPs, and PAs were held. Interactive training provided to improve vaccination rates and nursing assessment skills. Academic detailing provided to physicians to impact diagnostic and prescribing practices	Teleconsultations between the multidisciplinary team and site physicians, NPs, and PAs; Testing for Nursing Home–Acquired Pneumonia implemented.	Laminated pocket copies and preprinted orders of the care pathway

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
	Lau 2013	Geriatricians and nursing staff provided referrals for residents with certain medical conditions to manage their care in the LTC home by providing IV antibiotics & IV fluids, anticoagulation, oxygen therapy, and by enhancing access to Allied Health intervention and other support.	--	--	--
	Lisk 2012	Geriatricians provided consultations and community pharmacists performed medication reviews; An external nursing service provided on-site intravenous antibiotics and fluids	--	Teleconsultations between geriatricians and site staff (Monday–Friday 9 am to 5 pm); Email alert system to inform geriatricians and the external nursing service when a resident was admitted to hospital	End of life care document to help residents and their relatives to document their wishes
	McCarthy 2020, USA	Unclear how LTC home financial incentives from the Hospital Readmission Reduction Program might have impacted human resources. New Collaborations between the Program organizations and sites were noted.	Training to site staff on clinical assessment and treatment of residents who experienced a change in condition and whose conditions could be managed effectively onsite		MDS assessments used to identify residents who recently progressed to the advanced stages of dementia, CHF, or COPD
	Montalto 2015	Acute medical, pharmaceutical, and nursing care to provide oxygen and intravenous antibiotics and fluids, blood tests pathology on-site	--	Mobile radiology services provided onsite	--
	Wills 2018	"Community matrons care home teams" comprising senior nurses (matrons), advanced clinical practitioners, clinical nurse specialists, district nursing and rehabilitation services (occupational therapy, speech and language therapy, physiotherapy and rehabilitation support worker) provided integrated care service	First Person on Scene training programme provided to personal support workers (carers) to enhance their situation management skills; Bespoke course (Hospital avoidance) provided to site staff included basic instruction in taking, recording, monitoring and understanding baseline observations	--	--

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
Category 4. Transitional Care Interventions					
RCT (n=1)	Cordato 2018	Geriatrician and NP provided post-discharge evaluations for a period of 6 months (first LTC home visit in 1-week post-discharge from hospital, and then monthly visits)	--	--	--
NRS (n=10)	Brock 2013	External QI staff guided the implementation of multiple evidence-based interventions in care transitions, monitored performance, and assured sustainability	Training for the site staff on implementing evidence-based interventions, interpreting rehospitalization data and process control charts, and modifying approaches as needed.	--	Several tools used (e.g., INTERACT, BPIP, etc.) depending on the location of implementation
	Craswell 2020	NP candidate communicated with the Geriatric Emergency ED Team physician and other NPs) regularly about residents who required transfer to hospital; provided early intervention and advanced assessment to streamline care for each resident and to reduce ED length of stay, hospitalization, and repeat transfers	NP candidate collaborated with the physician in the care of residents, promoted ACP, and provided training to site staff	Teleconsultations between the ED team and site nursing staff prior to resident transfer	--
	Fan 2016	ED-based nurses were allocated to manage LTC home residents, a key contact ED nurse with geriatric care experience provided senior medical decision-making at an early stage of presentation to ED, intervention team coordinated ED discharge	Acute care support and training provided to site physicians and staff	--	--
	Jensen 2016	Extended Care Paramedics with additional specialized training responded to LTC homes from 9 am-9 pm for 2 weeks, provided assessment and treatment of certain conditions, consulted with LTC physicians to develop specialized care plans, to facilitate high quality of death	--	--	--

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
	Marsden 2020	Nurse-led, physician-championed, intervention delivered in the ED by advanced practice nurses, receiving community referrals from the primary care team, site staff and the ambulance services	ED staff training program: Treatment/care plans communicated to onsite physician/staff and families to ensure smooth return to the LTC home	Intervention nurses received referrals both directly and electronically.	--
	Marshall 2016	33 family physicians (one per floor) with care of the elderly training performed weekly onsite visits to residents identified by nurses as needing primary care and 24/7 on-call coverage for urgent/emergent issues. Extended care paramedics provided on-site acute care and facilitated coordinated ED transfers	An interdisciplinary training program provided to improve team coordination, communication, and end-of-life care. Interdisciplinary team approach implemented involving regular team meetings (physicians, site nurses, care assistants, paramedics, pharmacists, social workers, occupational/physio/recreational therapists)	--	Physician 'standards of care' form, end-of-life orders, on-call guidelines, diabetes guidelines, and comprehensive geriatric assessment tool
	McCarthy 2020, Ireland	A specialist geriatrician in the community provided consultation to LTC home physicians to optimize the management of chronic illness, ACP, and prompt follow-up for patients recently discharged from acute care	ACP and core skills training (e.g., management of weight loss, falls prevention, dementia care, medication review) provided to site staff	--	--
	Shrapnel 2019	A specialist nurse was employed to coordinate all key partners involved in LTC home resident care	Training for site staff, physicians (e.g., wound care, device care); Physician provided self-management education to residents without cognitive impairment	Teleconsultations for site staff, physicians, families for transfer decision-making&ACP	--
	Street 2015	A team comprised of nurses with gerontology expertise, supported by a geriatrician, supported site staff when residents became clinically unwell. Residential In-Reach coordinators provided clinical advice and telephone triage, and was available to attend the resident onsite	Geriatric assessment/management skills training provided by residential in-reach coordinators to site staff	Teleconsultation 'hotlines' for nursing and medical staff	--
	Zafirau 2012	Geriatric NPs supported by a geriatric physician	University-based on-site continuing education programs for staff; Individual sites developed in-service training programs	--	--

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
Category 5. Enhanced Usual Care Interventions					
RCT (n=4)	Arendts 2018	NPs with autonomous scope of practice diagnosed and prescribed medications (with LTC physician support as needed)	Patient and/or family education provided regarding diagnosis and prognosis, Root cause analysis of unplanned hospitalizations conducted by staff	--	Comprehensive medical assessment, care pathways, palliative care plan, QI tool, ACP, Medication review
	Boyd 2014	GNS provided regular bimonthly visits, support for transfer decision-making, clinical coaching, care coordination for high-risk residents, Wound care consultant	Standardized bimonthly site staff training on managing the behavioural and psychological symptoms of dementia and related medical issues; Geriatricians and allied health, hospital/primary healthcare/palliative care, needs assessment services liaised across primary and secondary care services.	GNS teleconsultations with site staff	Comprehensive geriatric Assessment, RN Care Guides
	Cavalieri 1993	Geriatricians and geriatric NPs conducted comprehensive geriatric assessments.	--	--	--
	Connolly 2015	GNS and study geriatrician led staff education and multidisciplinary team meetings	Training and clinical coaching for site staff on ACP, nutrition/hydration, early detection of illness, falls prevention, end-stage dementia care, communication with families, and practical aspects of care; Monitoring and benchmarking of resident indicators linked to quality of care (falls, nutrition, restraint use, weight loss, urinary tract infections, residents on >9 medications); Multidisciplinary team meetings and medication reviews among study geriatrician, GNS, site physician, pharmacist, and nurse manager	--	--

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
NRS (n=24)	Ackermann 1998	Gerontologist PA provided medical care and nearly all acute care visits in LTC home, visited facility 3-4 times (12-15h) per week, and followed the progress of hospitalized residents. Calls from LTC nurses were directed to the PA during regular working hours.	--	--	--
	Aigner 2004	A NP was added to physician team	--	--	--
	Burl 1998	Full-time Geriatric NP was recruited to work with one full-time internist to provide care and communicate with families	--	--	--
	Codde 2010	ED-based nurses provided clinical review, acute and chronic wound care, replacement of catheters, IV and subcutaneous fluids, blood transfusion, and referrals to in- or out-of-hospital services (from 8am to 4pm, 7days/week)	Training and upskilling on treatment delivery onsite (e.g., wound care) provided to site staff	Teleconsultations between ED-based nurses and site staff. Referrals was made via government-run LTC home teleconsultation line. Nurses then consulted each episode of care with a primary care physician who affirmed their care plan or referred the resident to ED	--
	Connolly 2018	GNS performed baseline facility assessment to identify needs, made facility care plan, and provided clinical coaching for site staff. A study geriatrician and pharmacist participated in multidisciplinary team meetings	Three 1-hour multidisciplinary team meetings, priority given to residents who were recently admitted hospitalized, with recent 'incidents' (e.g., fall), or on >9 medications	--	--
	Gloth III 2011	A geriatrician provided attending physician duties for at least 70% of the LTC home residents and was present in the facility at least 3 times/week. A NP was also hired.	--	--	--

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
	Graham 2017	An RN*(Practice development facilitator) delivered preventive care, trained site staff trainers and supported competence assessments	1-2 RN champions per site provided general training and then master classes (e.g., clinical skill acquisition)	--	SBAR communication tool
	Hex 2015	"Telehealth Hub" physicians and nurses responded directly to patients and their carers via telemedicine	--	Telemedicine: 24-hour service	
	Hullick 2016	An aged Care Emergency Clinical Nurse Consultant and 4 ED nurses	Training provided to site staff on using the algorithms (2 hours of presentation with ongoing training as required or requested)	Teleconsultations between Emergency Clinical Nurse Consultant and site staff 12 h/day, 7 days/ week to provide clinical support, assist decision making, receive clinical handover for transferred residents	Evidence based algorithms to help manage common problems for acutely unwell residents (e.g., falls, shortness of breath and indwelling urinary catheter issue)
	Lacny 2016	A NP in collaboration with a physician organized interdisciplinary care, medication review meetings, and communication with families and ACP	--	--	--
	Lloyd 2019	Each LTC home was aligned with a general practice: A primary care physician visited the LTC home on a regular (weekly or every 2 week) basis, met registered residents, and reviewed their medications and care plans. 3 teams of community nurses offered peer-to-peer support to LTC nurses. Information to residents and families about whether to change to the aligned local general practice after moving to the LTC home was provided by an independent organization.	Training on falls, heart failure, palliative care, wound care, catheter care, sepsis and pressure sore management provided by community nurses to site staff. A community nurse with a special interest in palliative care visited sites regularly and provided end-of-life training, including pain management. Falls training provided to frontline staff, administrative, ancillary and kitchen staff. Site managers met bimonthly; intervention team representatives met monthly.	--	--

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
	Lukin 2016	A team of ED-based nurses provided a range of procedures, (e.g., urinary catheter change, parenteral antibiotic administration, and wound care) onsite.	Providing support and training for site staff and physicians to increase their knowledge and confidence in the acute care for residents	--	--
	Jung 2015	Interdisciplinary team with geriatric expertise and a focus on extensive primary and preventive care. The state contracts with qualified managed care plans on a capitated basis to provide the complete benefit package	--	--	--
	Kane 1989	Geriatric NP	--	--	--
	Kane 1991	NPs and PAs provided primary care (using a pay model as incentive)	--	--	--
	Kane 2003	NP (using a pay model as incentive)	--	--	--
	Kane 2004	NPs (in collaboration with an LTC physician) provided increased primary care services	NPs provided training for nursing staff and personal support workers on improving observation skills and care	--	--
	Kumpel 2020	Pay model as incentive: Flat rates to physicians visiting LTC patients onsite, reimbursement for treating LTC home residents, and for organizing treatment pathways	--	--	--
	Ono 2015	One full-time NP working onsite performed medical interview, physical assessment, and/or designated medical tests, selected and/or administered medication, changed gastrostomy tubes or debrided a decubitus ulcer)	NP underwent training and then collaborated with site physician and staff, and met /consulted with resident families to explain their current health status, needs and treatments	--	--

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
	Reuben 1999	<table><tr><td></td><td colspan="3">Pay Model Plan</td></tr><tr><td></td><td>A</td><td>B</td><td>C</td></tr><tr><td># Physicians</td><td>5</td><td>12</td><td>2</td></tr><tr><td># NP/PAs</td><td>4</td><td>5</td><td>2</td></tr></table>	--		--
	Rolland 2016	Senior hospital geriatricians (working in a department of geriatrics at the nearest public hospital volunteered to participate)	Training for site staff on quality indicators, functional decline, evaluation of the risk of pressure ulcers, and ED transfers of residents; Quality audit and feedback	--	”Standardized tools (not specified)” to evaluate pain, behavioral disturbance, and mood
	Weatherall 2019	1 dedicated physician (per site) treated patients and met with site staff weekly (1.5 to 3 hours) to discuss clinical needs of residents and how to treat common health conditions. Residents were encouraged, but not required, to receive care from this dedicated physician	A dedicated physician met with site staff weekly (1.5 to 3 hours/week) to discuss the clinical needs of each patient and to provide training on how to treat common health conditions among all residents.	--	--
	Wieland 1986	Geriatrician, physicians assigned to groups of patients, and geriatric NPs were hired to provide day-to-day care. Allied health personnel including students involved in the academic nursing home model assisted with intervention implementation.	Interdisciplinary training for site staff on identifying, assessing, and managing selected conditions on site; Outcome monitoring with feedback; Quarterly interdisciplinary team meetings; Educational resources (videos, bulletin boards, bimonthly unit sessions to address specific concerns and topics)	--	--
	Xing 2016	Additional nursing staff, and higher benefits and wages were realized by the new reimbursement plan	--	--	--

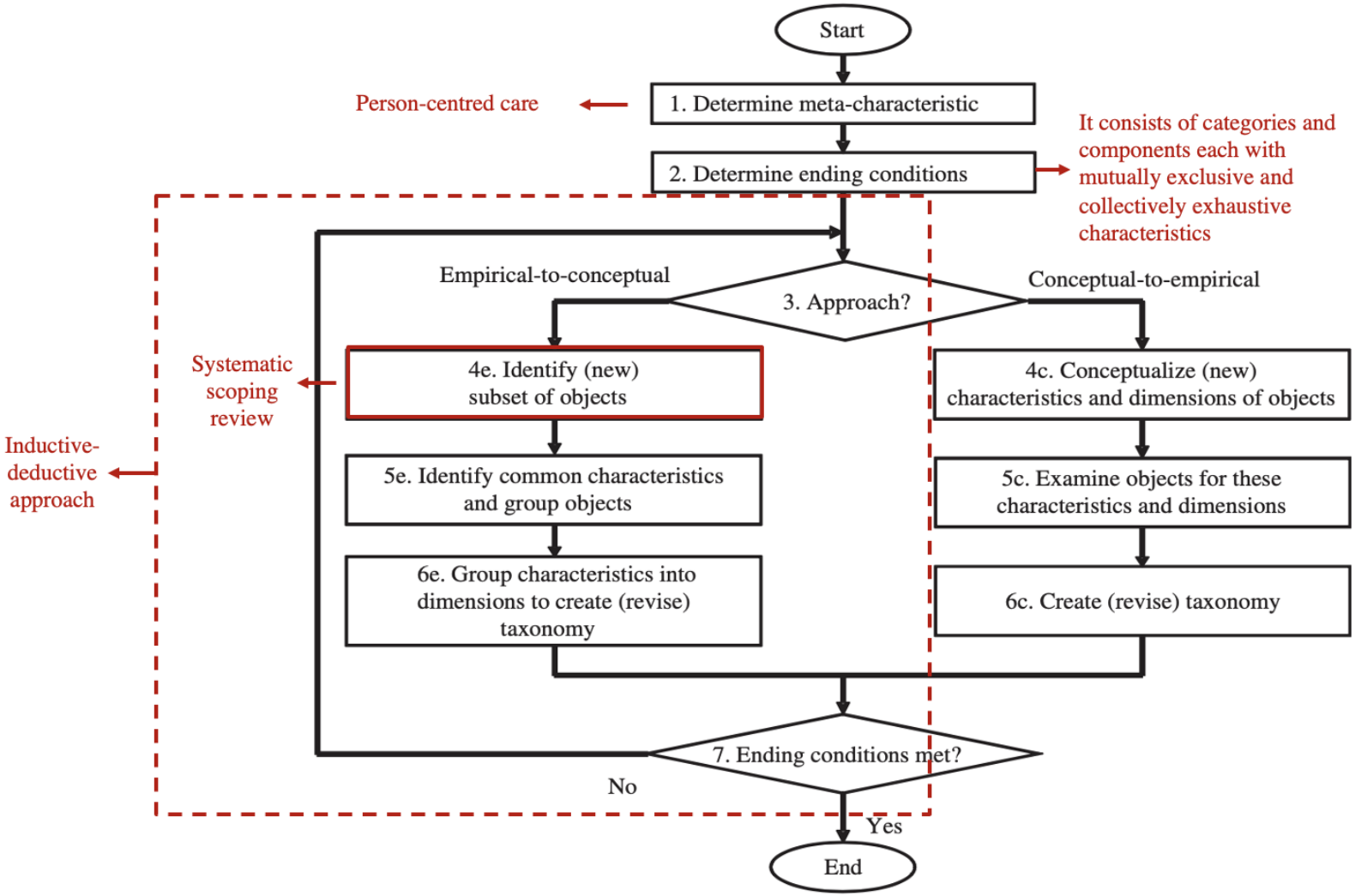
Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
6. Comprehensive Care Interventions					
RCT (n=1)	Kane 2017	1 Experienced geriatric NP	Project champions and co-champions selected from each site; INTERACT Curriculum, 12 sessions training with evaluation	Teleconsultations between geriatric NP and site staff every 2 weeks, online resources, and weekly teleconference review for all staff	INTERACT toolkit: Stop and Watch early warning tool, SBAR and Progress Note, Change in Condition File Cards, Resident transfer Forms, Transfer checklist envelope, Care Paths, Medication reconciliation sheet, Advance care planning tools, Hospital communication tools
NRS (n=6)	Blackburn 2020	Full-time RNs champions were employed in each LTC home to work with staff. 7 full-time NPs covering 3-4 LTC homes performed in-person evaluations and management of residents with acute changes or recent transition from the hospital, project geriatrician	Training for staff on Respecting Choices Last Steps Physician Orders for Scope of Treatment (POST) and the End-of-Life Nursing Education Consortium-Geriatric curriculum, a train-the-trainer educational program; RNs and NPs conducted structured collaborative care reviews	RNs and NPs had electronic access to a national network, detailed clinical information from the major hospital systems in the area and made Teleconsultations between RNs and NPs and project geriatrician to finalize collaborative care reviews	INTERACT care pathways and tools designed to improve communication
	Giebel 2020	A "community matron" (senior nurse who may have a master's degree and non-medical prescribing qualifications) worked weekday 9am-5pm and provided reactive care for urgent presentations and ACP. Primary care physician provided support and advice as the registered doctor. Community geriatrician provided support and advice including joint visits or reviews	Basic training provided for site staff in taking observations and applying protocols; Bi-monthly collaborative multi-disciplinary team meetings were held among district nurses, palliative care nurses, urgent care teams, community geriatricians, and medicines management; Monthly newsletter	Telemedicine provided by an advanced NP who performed remote assessment for residents (24/7 access).	3 clinically derived protocols for initial management of common problems e.g., falls, head injury.

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
	Ouslander 2011	Senior project coordinator*	Site champions were identified; Training and educational resources provided for site staff; Corporate and site leadership participated in in-person and telephone meetings to discuss project goals and expectations; Acute care transfer monitoring with feedback (QI analysis)	Teleconsultations facilitated by the senior project coordinator held every 2 weeks with site champions	INTERACT toolkit
	Tena-Nelson 2012	An LTC home association, initiated an INTERACT collaborative QI program and provided customized training for LTC home leadership and staff, including an overview of the program and its tools, hands-on implementation support, and data collection support for self-evaluation	Same as described above + 1 in-person briefing for site executives, 1 session for utilizing the tools, affiliated hospital staff attending 2 learning sessions, 1 session to empower site staff, and a joint staff-management project to advance person-centered care. The extent of training and skills development depended on the composition of the teams and varied among sites	Teleconsultations facilitated by the senior project coordinator held every 2 weeks with site champions	INTERACT toolkit
	Vadnais 2020	RNs/ advanced practice RNs who delivered aspects of the care models onsite were hired (there was a flexibility in the activities they provided onsite).	Training on the INTERACT tools and other topics provided to site staff	Telemedicine carts connecting on-call advanced practice RNs with LTC nurses allowing a remote assessment after-hours Systems Secure text messaging for the electronic transfer of resident data between hospitals and nursing facilities INTERACT Transition Tool in Electronic Medical Records	INTERACT toolkit

Design	Ref.	Increasing Human Resource Capacity	Training† or Reorganization of Existing Staff	Technology	Standardized Tools
	Vogelsmeier 2021	1 full-time advanced practice RNs focused on basics of care delivery, early illness detection, acute illness management, medication reviews, and systems changes. A multi-disciplinary team (comprised of a medical director, nurse project supervisor, INTERACT/QI coach, health information coordinator, and social worker) oversaw care transitions. 4 researchers* provided expertise in QI, care coordination, ACP, informatics, and transitional care	INTERACT program implemented in each facility In Phase 2, the new payment intervention while sustaining the successful intervention implemented during Phase 1	Health information exchange technology (a web-based interface for secure entry for all eligible resident enrollment, hospital transfers, and other required reporting) was implemented to facilitate communication between site staff and providers	INTERACT toolkit
	Zúñiga 2022	1 RN with LTC home experience was appointed per site to enhance geriatric expertise, initiate comprehensive geriatric assessments of residents when a change in condition was observed	Internal structures were developed to increase interprofessional collaboration between physicians and site staff; Coaching and training sessions for site staff on the tools; ACP to help sites initiate sensitive discussions and document residents' wishes; Reflection with the care team about unplanned hospitalization (Data-driven QI)	Teleconsultation with care staff before they contact the physician	INTERACT tools: "Stop and Watch Early Warning Tool", "the SBAR Form", and "the QI Tool for Review of Acute Care Transfers", Advance Care Planning, and modified versions of the "Care Paths" Customized electronic Case Report Form

*Research staff involvement for intervention implementation
†Where possible, information pertaining to training intensity is provided
‡Teleconsultation: Clinical consultation or transfer decision-making support from experts to LTCF staff via telephone, e-mails, or videoconference
§Telemedicine: Clinical assessment and/or patient management via web-based applications (e.g., videoconferencing systems, telemedicine carts, or exam cameras)
ACP: Advance care planning; CNS: Clinical Nurse Specialist: ED: Emergency Department; EOL: End-of-life; INTERACT: Interventions to Reduce Acute Care Transfers; LTC Home: Long-Term Care Home (consolidating reported geographic-specific terminology); NP: Nurse Practitioner; NRS: Non-randomized Studies; PA: Physician Assistant; PC: Palliative care; POST: Training for staff on Respecting Choices Last Steps Physician Orders for Scope of Treatment; QI: Quality Improvement; RCT: Randomized Controlled Studies; RN: Registered Nurses; SBAR: Situation, Background, Assessment, Recommendation; MDS: Minimum Data Set

4.14.7 Supplemental Figure 1. Taxonomy development method



Adapted from Nickerson et al. A method for taxonomy development and its application in information systems. Eur J Inf Syst 2013; 22(3): 336-59.

Notes: The taxonomy was developed via an iterative analysis of intervention descriptions:

1. Person centred care was determined as the meta-characteristic.
2. Ending conditions were determined as intervention categories (*when, for whom, and how*) and components (*what*) each with mutually exclusive (i.e., each group is completely distinct and there is no overlap) and collectively exhaustive (i.e., the sum of all groups covers all possible options) characteristics.
3. An empirical-to-conceptual approach was taken since no framework was available.
4. A systematic and comprehensive search was performed to identify intervention studies.
5. Common characteristics were identified, and interventions were grouped.
6. The taxonomy for categories and components were created (and revised iteratively).
7. The inductive-deductive approach was repeated until ending conditions were met.

4.15 Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	29
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	29,30
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	31
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	31,32
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	32
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	32
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	33
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Supplemental Table 2 and 3
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	34
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	34
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	34
Critical appraisal of individual	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	34

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
sources of evidence§		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	34,35
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	37, Figure 4.1
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Supplemental Table 4
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Supplemental Table 5
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Table 3, Supplemental Table 6
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	35-36 Table 4.1, Table 4.2, Figures 4.2a and 2b, Table 4.3
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	50-54
Limitations	20	Discuss the limitations of the scoping review process.	54,55
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	55
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	56

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

CHAPTER 5: MEASURING POTENTIALLY AVOIDABLE ACUTE CARE TRANSFERS FROM LONG-TERM CARE HOMES IN QUEBEC: A CROSS SECTIONAL STUDY (MANUSCRIPT 2)

5.1 Preamble

Primary care physicians, nurses, and other staff working in LTC homes are expected to reduce potentially avoidable acute care transfers to improve the continuity, efficiency, and quality of care for this frail population. There are, however, challenges that exist for both LTC home clinicians and administrators with respect to identifying and monitoring these outcomes in a meaningful way.

First, several definitions for 'potentially avoidable' transfers exist. Some include both preventable conditions (e.g., falls and trauma) and conditions that are manageable in LTC homes (e.g., pneumonia) as part of their definition. There is a lack of evidence that focuses on medical conditions that are *clinically manageable* in the LTC setting. This approach would ultimately be beneficial to developing more focused and effective approaches for LTC front-line staff who are faced with time-sensitive decisions pertaining to episodes of acute health deterioration by residents under their care.

Second, there are problems pertaining to understudied outcome metrics. Hospitalizations from LTC were the predominant focus of the literature to date. Given that decisions to hospitalize are rendered by acute care staff once a resident has already been transferred, there is a need to conduct a thorough investigation into potentially avoidable ED transfers (i.e., transfers both with and without subsequent hospitalization).

These challenges are more apparent in the province of Quebec which does not report LTC transfers data to the Canadian Institute for Health Information as part of the national Continuing Care Reporting System. For this reason, there has been no reporting of this phenomenon in Quebec to date.

As such, the objective of this second substudy was to operationalize potentially avoidable transfer outcome measures (both ED transfers and hospitalizations) for conditions that are 'clinically manageable' in a Quebec network of LTC homes. This was also the first time that potentially avoidable ED transfers and hospitalizations from LTC homes were investigated in Quebec and compared to the rest of Canada. This study was conducted in partnership with the Integrated Health and Social Services University Network for West-Central Montreal (Centre

intégré universitaire de santé et de services sociaux du Centre-Ouest-de-l'Île-de-Montréal). The "Med-Urge electronic database" is one of the systems used in Quebec Hospitals (Le système d'information de gestion des urgences). I used Med-Urge data to identify residents received at one tertiary hospital ED from the 7 LTC homes in the Network and analyzed variables pertaining to ED visits and hospitalizations. Results of this article informed the selection of potentially avoidable acute care transfer outcome measure for the directed acyclic graph created in the third manuscript.

The following article is currently in press at The Canadian Geriatrics Journal (April 2023).

Title: Measuring potentially avoidable acute care transfers from long-term care homes in Quebec: A cross sectional study

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5.2 Abstract

Background: Potentially avoidable emergency department transfers (PAEDTs) and hospitalizations (PAHs) from long-term care (LTC) homes are two key quality improvement metrics. We aimed to 1) Measure proportions of PAEDTs and PAHs in a Quebec sample, and 2) Compare them with those reported for the rest of Canada.

Methods: We conducted a cross-sectional study of residents who were received at one tertiary hospital between April 2017 and March 2019 from 7 LTC homes in Quebec, Canada. The MedUrge emergency department database was used to extract transfers and resident characteristics. Using published definitions, PAEDTs and PAHs were identified from principal emergency department and hospitalization diagnoses, respectively. PAEDT and PAH proportions were compared to those reported by Canadian Institute for Health Information.

Results: A total of 1,233 transfers by 692 residents were recorded, among which 36.3% were classified as being potentially avoidable: 22.8% 'PAEDT only', 11.6% 'both PAEDT & PAH', and 1.9% 'PAH only'. Shortness of breath was the most common reason for transfer. Pneumonia was the most common diagnosis from the 'both PAEDT & PAH' category. PAEDTs and PAHs accounted for 95% and 37% of potentially avoidable transfers, respectively. Among 533 hospitalizations, 31.3% were PAHs. These proportions were comparable to the rest of Canada,

with some differences in proportions of transfers due to congestive heart failure, urinary tract infection, and implanted device management.

Conclusions: PAEDTs far outweigh PAHs in terms of frequency, and their monitoring is important for quality assurance as they may inform LTC-level interventions aimed at their reduction.

5.3 Introduction

Despite receiving 24-hour nursing care, long-term care (LTC) home residents are frequently transferred to acute care settings in response to a health status change.[1,2] Some of these transfers are potentially avoidable,[3] i.e., could theoretically be circumvented by timely and effective in-facility care.[4] The lack of consensus regarding how to conceptualize and measure 'potentially avoidable transfers' from LTC presents a methodological challenge.[3] The factors involved are complex, including the management of early-acute or low-acuity symptoms,[5] post-hoc assessment of factors contributing to avoidability (e.g., facility capabilities,[5] burdensome transitions at the end of life,[6] transfers contrary to advance directives[7,8]), or, more commonly, the measurement of ambulatory care sensitive conditions (e.g., pneumonia, hypertension).[5]

Investigations of potentially avoidable transfers from LTC homes have typically reported on potentially avoidable emergency department transfers (PAEDTs) or potentially avoidable hospitalizations (PAHs), with the majority reporting on the latter. North American PAEDT estimates range from 25%[9] to 44%,[10] and PAH estimates vary considerably, ranging from 23% to 67%.[4,11-13] While using the ambulatory care sensitive condition approach to identify potentially avoidable transfers is relatively straightforward from a research perspective, there are challenges with its implementation in practice. In addition, further confusion exists as *preventable* conditions (e.g., falls and trauma) and conditions that are *manageable* in LTC homes (e.g., pneumonia) are often combined.[8,14]

Transfer decision-making processes are complex and typically involve primary care physicians, nurses, residents, and families or substitute decision makers.[15,16] Mechanisms that monitor potentially avoidable transfers in this setting can be useful to clinicians and administrators. Given that the province of Quebec does not take part in Canada's Continuing Care Reporting System,[17] however, no formal monitoring mechanism exists for these homes. To address these issues, the two objectives of this study were to 1) Measure the proportions of PAEDTs and PAHs

among transfers to a tertiary acute care setting from a Quebec LTC home sample, and 2) Compare our Quebec findings with those reported for the rest of Canada.

5.4 Methods

5.4.1 Study design

A repeated cross-sectional study was conducted in partnership with the Integrated Health and Social Services University Network for West-Central Montreal ("the Network"). This design was deemed appropriate for estimating the prevalence of PAEDTs and PAHs in LTC residents presenting to the ED. The results of this study are reported in accordance with the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement,[18] which is an extension of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.

5.4.2 Setting

This network includes one tertiary-care hospital and 7 publicly-funded LTC homes: three small (<100), two medium (100-200), and two large (>200), (1,189 beds in total). This hospital was selected as it receives, on average, 75% of all transfers from the 7 participating LTC homes. A LTC home was defined, using the Canadian Institutes for Health Information (CIHI)[19] and Canadian Association for Long-Term Care[20] definition, as an institution that provides care for older adults (and to a lesser degree, for younger adults), requiring 24-hour nursing and rehabilitation for chronic medical conditions or impaired mental capacity, and having significant deficiencies in activities of daily living.

5.4.3 Data sources and sample selection

We used MedUrge, an electronic triage and flow tracking system that allows ED clinicians to locate patients, access patient clinical information, and manage consultations, all with the aim of improving the quality of care.[21,22] Data pertaining to all acute care transfers by residents from the 7 LTC homes and rehabilitation centers who received care at one tertiary hospital ED between 1 April 2017 - 31 March 2019 were extracted to an Excel worksheet by the Network's Chief Information Officer and Performance Evaluation at the Quality, Evaluation, Performance, Ethics and Archives Department. Data were de-identified before being saved at the Hospital's Research Institute. Data cleaning was then conducted by checking for duplicates or inconsistencies in

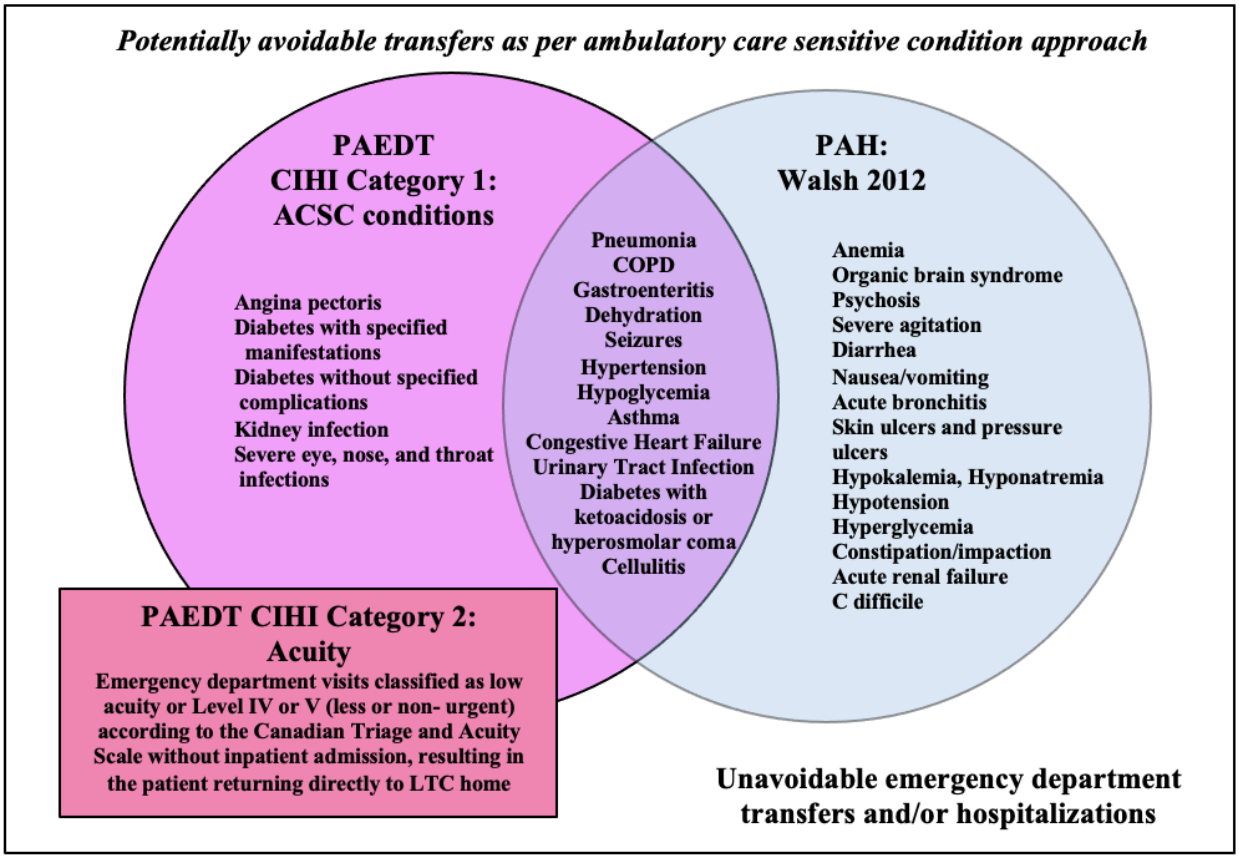
terminology (e.g., facility names, reasons for transfer such as 'dyspnea' vs 'shortness of breath'). To compare our data to all other provinces, we used the proportions of PAEDTs [23] and PAHs[8] reported by CIHI.

5.4.4 Measures

The following variables were extracted from the MedUrge database: The name of the facility of origin, residents' sex and age at the time of transfer, and transfer episode characteristics (day and time of ED arrival, the acuity according to the Canadian Triage and Acuity Scale),[24] principal ED diagnoses, ED length of stay, disposition after the ED episode, and, if admitted, diagnoses at the hospital admission and hospital length of stay. Due to the exploratory nature of the study, a 2-year study period was deemed to be sufficient. The 'facility type' and 'facility name' variables were used to exclude transfers that originated from LTC homes in other Networks, or from any intermediate care settings (e.g., assisted living facilities), or rehabilitation centers.

Assessment of transfer avoidability was conducted using definitions proposed by CIHI,[23] Walsh,[25] and Walker.[12] In Figure 5.1, we present a Venn diagram describing conditions included when considering PAEDT and PAH definitions, and the degree to which they overlap. We chose CIHI's PAEDT definition[23] for our primary analysis that includes visits "*for selected potentially preventable conditions—similar to ambulatory care sensitive conditions and validated for LTC home residents—for which timely primary care management could have been effective*" (CIHI *Category 1*), [23] visits classified as being *"Less Urgent"* or *"Non Urgent"* (low acuity) according to the Canadian Emergency Department Triage and Acuity Scale,[26] and visits *"without inpatient admission*, *resulting in the patient returning directly to LTC home"* (CIHI *Category 2*).[23] Category 1 PAEDTs were identified using principal ED diagnoses, while Category 2 PAEDTs were identified using the triage code and ED disposition for each transfer episode.[23] To measure PAHs, we used the Walsh et. al., definition, which includes a list of conditions validated for the LTC population and distinguishes between conditions that are 'manageable' and 'preventable' in the LTC setting.[25]

Figure 5.1 Potentially avoidable emergency department transfers and hospitalizations from long-term homes: Conditions



In order to compare our Quebec data with that from other provinces, proportions of CIHI Category 1 ambulatory care sensitive conditions (pneumonia, congestive heart failure, urinary tract infection, COPD, cellulitis, and other conditions) were extracted from the most recently available 2013-2014 CIHI report.[23] As the proportions of specific conditions for Category 2 are not published, we compared total proportions. We used the total proportion of PAH reported in another CIHI document presenting 2011–2012 data.[8]

5.4.5 Statistical analyses

Acute care transfer episodes were categorized by avoidability status and described by resident and transfer characteristics, the most common reasons for transfer, ED diagnoses, and hospital admission diagnoses. Descriptive analyses evaluating the degree to which each outcome measure contributed to overall potentially avoidable acute care transfers were calculated. More specifically, we compared proportions of PAEDTs and PAHs where the sum of all potentially

avoidable transfers was the denominator (transfers deemed to be PAEDTs and/or ultimately resulted in being PAHs). To investigate the degree to which our outcomes would align with a Canadian PAH definition, we also conducted a sensitivity analysis in which we used the list of conditions identified by Walker et al., that does not distinguish between manageable and preventable conditions.[12] Conditions that most frequently resulted in PAEDTs and PAHs were described and compared to the CIHI reports, where possible. R statistical software version 4.0.0 and SAS© software, version 9.4 were used for analyses.

5.4.6 Ethics approval

The Network's Research Review Office (Medical-Biomedical Research Ethics Committee) approved the study (Project 2019-1580). To protect confidentiality, names of residents and LTC homes were de-identified.

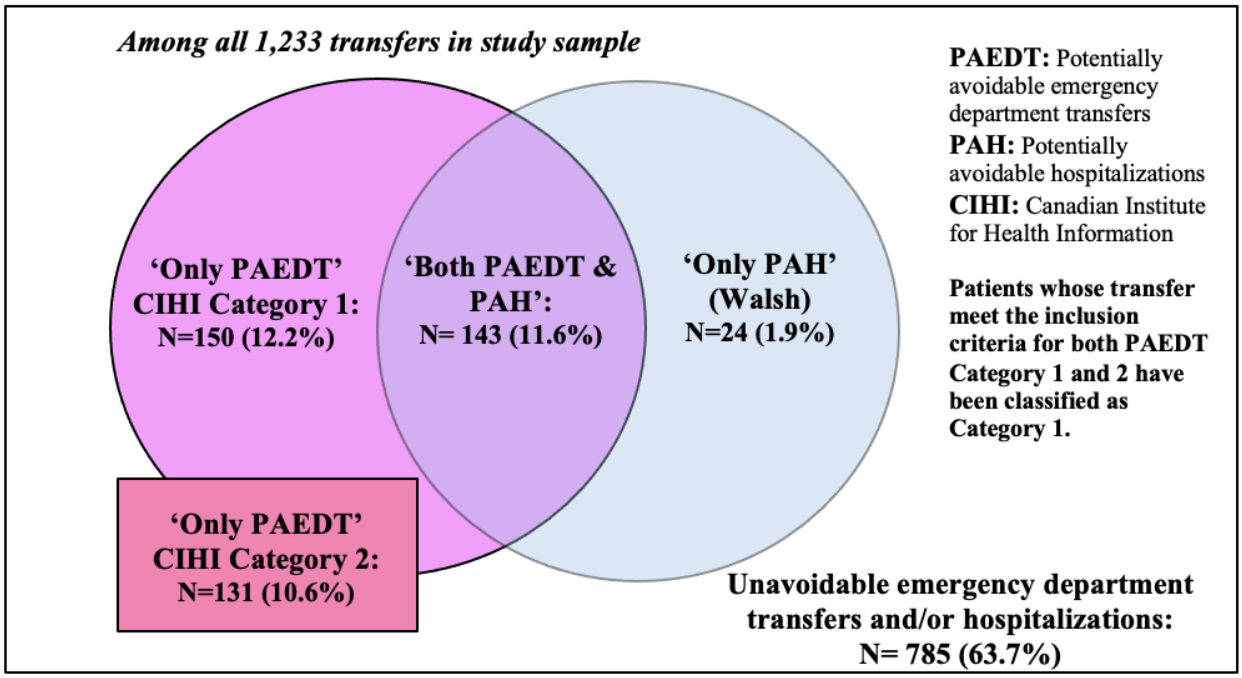
5.5 Results

5.5.1 Summary of transfer episodes

A total of 1,907 transfer episodes were initially identified. Among these, 671 episodes originated from ineligible facilities not providing 24-hour nursing care (e.g., rehabilitation centers) and 3 database duplicates (i.e., when a resident's triage code was updated in the ED resulting in separate database entries) were excluded. After exclusion, 1,233 transfer episodes by 692 residents were retained for study; 417 (60%) of residents were transferred once, 246 (36%) experienced 2 to 5 transfers, and 29(4%) experienced 6 to 12 transfers during the 2-year study period. In two transfer episodes, the reason why the resident left without being seen was unknown, but in both cases, these were categorized as being unavoidable given that their triage codes were II and III. In 5 transfer episodes where the hospital admission diagnosis was missing, avoidability status was assigned using the principal ED diagnosis.

In total, 448 transfer episodes (36.3%) were classified as being potentially avoidable. In Figure 5.2, we reported the proportions of transfers classified by their avoidability status. Proportions of 'PAEDT only' CIHI Category 1, 'PAEDT only' CIHI Category 2, 'both PAEDT & PAH', and 'PAH only' from among all transfers corresponded to 12.2%, 10.6%, 11.6%, and 1.9% of our sample, respectively.

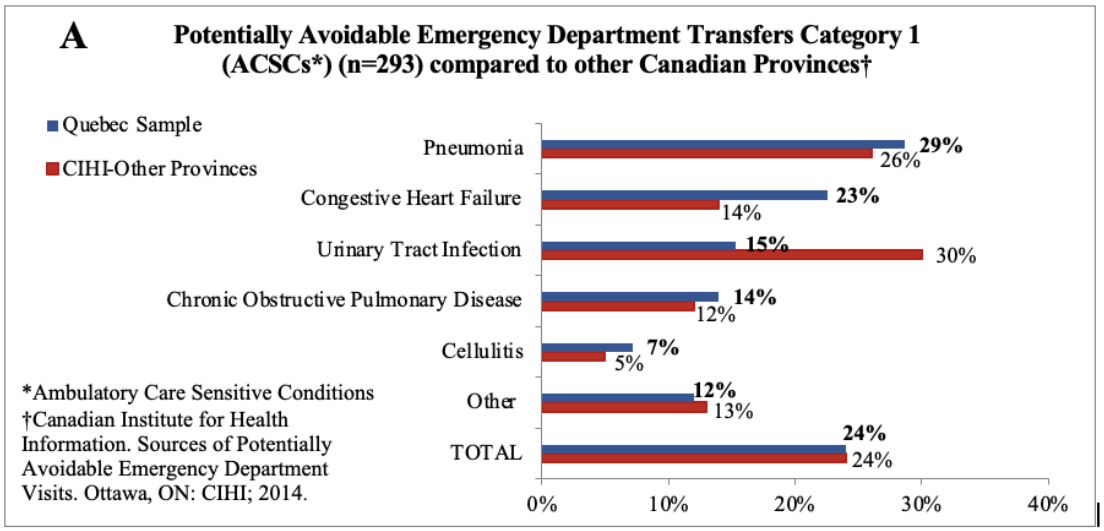
Figure 5.2 Potentially avoidable emergency department transfers and hospitalizations from long-term care homes: Proportions in study sample

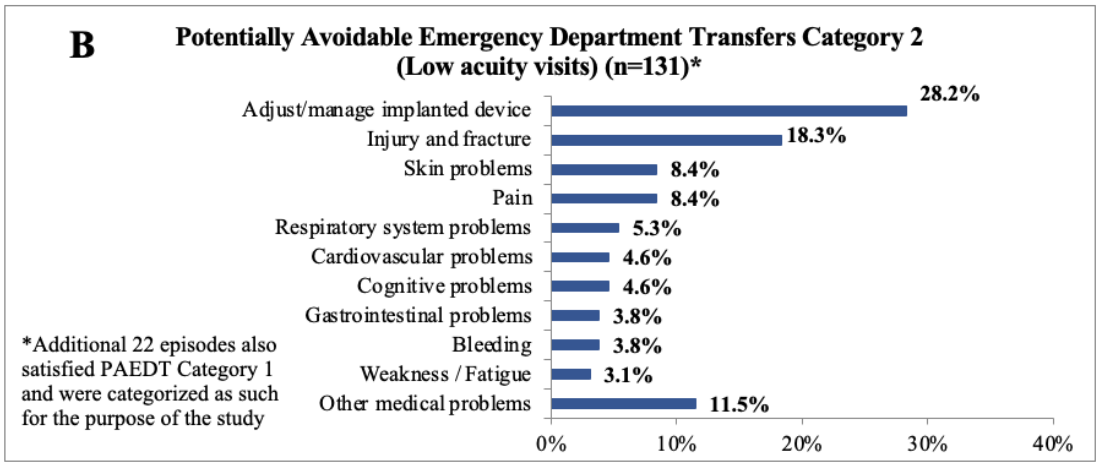


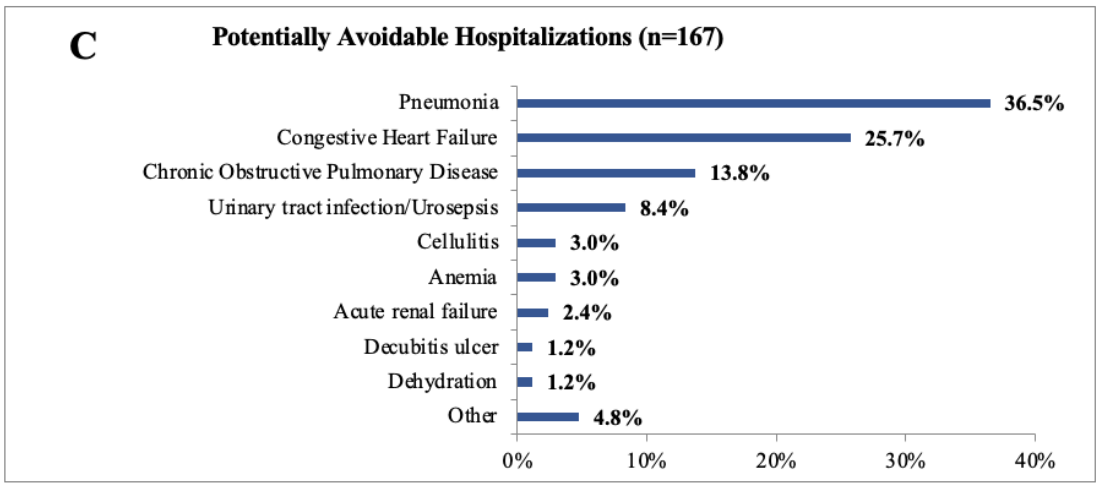
5.5.2 Comparison of the Quebec sample with the rest of Canada

The proportions of ED diagnoses among PAEDTs and hospital diagnoses among PAHs are shown in Figure 5.3. In total, 293 episodes belonged to PAEDT Category 1, among which pneumonia was the most frequent condition followed by congestive heart failure, urinary tract infection, chronic obstructive pulmonary disease, and cellulitis (Figure 5.3A). "Other" conditions included seizure, dehydration, severe eye, nose, and throat infections, angina, gastroenteritis, hypoglycemia, kidney infections, diabetes, hypertension, and asthma. In Quebec, PAEDT Category 1 accounted for 24% of all transfers, which was identical to the rate reported in the rest of Canada.[23] Within this category, the Quebec sample had a higher frequency for heart failure (23% vs.14%) and lower frequency of transfer for urinary tract infection (15% vs. 30%).[23]

Figure 5.3 Principal emergency department and hospital admission diagnoses







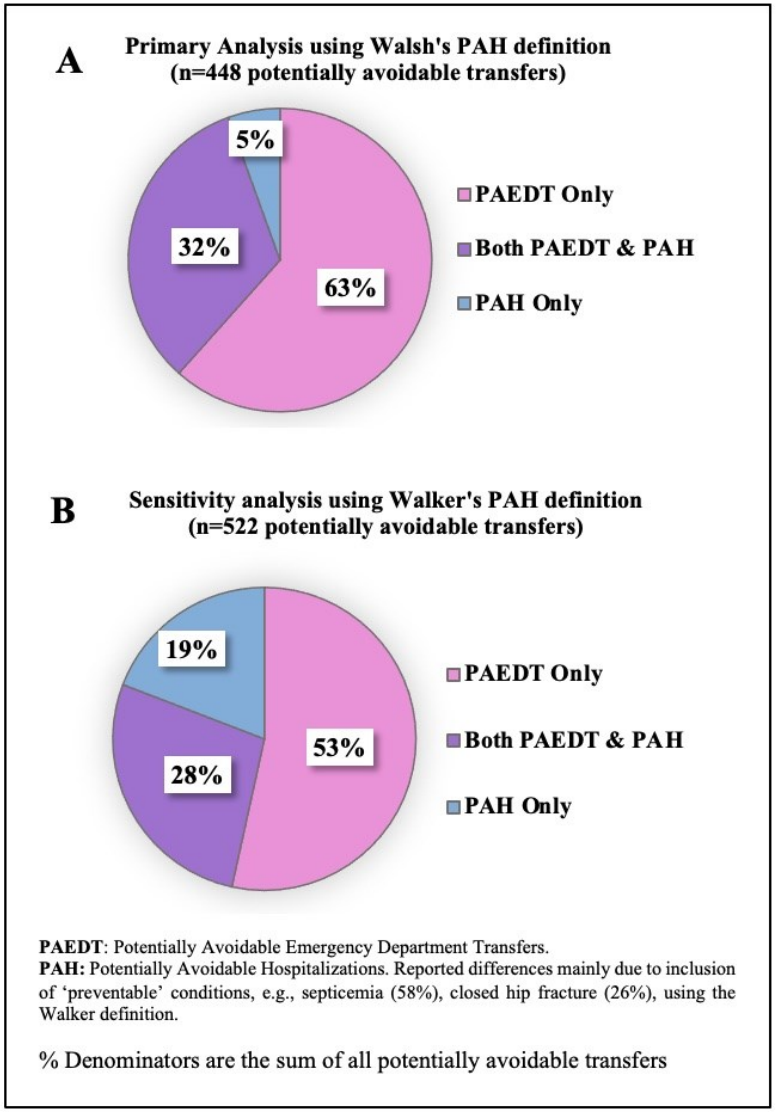
A total of 131 episodes belonged to PAEDT Category 2 (Figure 5.3B). We categorized final ED diagnoses into the following 11 groups: Adjustment and management of implanted devices, injury and fracture, skin problems, pain, respiratory system problems, cardiovascular problems, cognitive problems, gastrointestinal problems, bleeding, weakness/fatigue, and other problems (such as retention of urine, anemia, or hemorrhoids). Other medical problems included retention of urine, localized edema, anemia, ascites, hemorrhoids, hypernatremia, gynecological neoplasms, paresthesia/numbness, and counselling/medical advice. Overall PAEDT Category 2 from the Quebec sample accounted for 10.6% of all transfers, which was again identical to that in the rest of Canada (10%).[23] 'Adjustment and management of implanted devices' was the most frequent principal ED diagnosis within this category in Quebec (28.2%), followed by injury and fracture (18.2%), whereas the most frequent "diagnosis" in the rest of Canada in this category was falls (25%).[23]

Among 533 hospitalizations, 31.3% were found to be potentially avoidable (Figure 5.3C) using the Walsh definition. Using the Walker PAH definition (as reported by CIHI), we found that the Quebec PAH prevalence as a proportion of hospitalizations was comparable to the rest of Canada (47% vs 45%, respectively).[8] The five most frequent conditions for PAHs were same as those for PAEDTs mentioned above, followed by anemia, acute renal failure, decubitus ulcers, dehydration, and other conditions (e.g., diabetes with hypoglycemia, gastroenteritis/diarrhea, hypertension, hyponatremia, hypotension, nausea with vomiting, open wound/infection, and seizures/convulsions).

5.5.3 Potentially avoidable transfers - A Comparison of PAEDTs vs PAHs

Figure 3 presents the contribution of PAEDTs and PAHs within the subset of potentially avoidable acute care transfer episodes. When using our primary analysis Walsh PAH definition (Figure 5.4A), the PAEDT outcome measure was dominant, as it captured, in total, about 95% of all potentially avoidable transfers, whereas in our sensitivity analysis using Walker's definition (Figure 5.4B), PAEDTs captured 81%. The PAH measure captured 37% and 47% of all potentially avoidable transfers when using the Walsh vs. Walker definitions, respectively. These differences occurred mostly due to the inclusion of septicemia and closed hip fracture (which are 'preventable' as opposed to 'manageable' conditions in the Walker definition).

Figure 5.4 Proportions of PAEDTs and PAHs



Ambulatory care sensitive condition definitions

	PAEDT CIHI Category 1	PAH Walsh 2012	PAH Walker 2009
Angina pectoris	✓		✓
Diabetes with specified manifestations	✓		✓
Diabetes without specified complications	✓		✓
Kidney infection	✓		✓
Severe eye, nose, and throat infections	✓		
Pneumonia	✓	✓	✓
COPD	✓	✓	✓
Gastroenteritis	✓	✓	✓
Dehydration	✓	✓	✓
Seizures	✓	✓	✓
Hypertension	✓	✓	✓
Hypoglycemia	✓	✓	✓
Asthma	✓	✓	✓
Congestive Heart Failure	✓	✓	✓
Urinary Tract Infection	✓	✓	✓
Diabetes with ketoacidosis or hyperosmolar coma	✓	✓	✓
Cellulitis	✓	✓	✓
Anemia		✓	
Organic brain syndrome		✓	
Psychosis		✓	
Severe agitation		✓	
Diarrhea		✓	
Nausea/vomiting		✓	
Acute bronchitis		✓	
Skin ulcers and pressure ulcers		✓	
Hypokalemia, Hyponatremia		✓	
Hypotension		✓	
Hyperglycemia		✓	
Constipation/impaction		✓	
Acute renal failure		✓	
C difficile		✓	
Dental conditions			✓
Septicemia			✓
Fracture			✓
Injuries from fall			✓

5.5.4 Episode characteristics by avoidability outcomes

Table 5.1 presents patient and acute care transfer-level characteristics classified by transfer avoidability outcome measure. Among all transfers, only 17% were low acuity, but this proportion increased to 58% within the PAEDT category. In Table 5.2, the reasons for transfer as provided by the LTC home, ED and hospital admission diagnoses are presented by avoidability outcome among all transfers and those that resulted in hospitalization. Shortness of breath was the most common LTC reason for transfer, while pneumonia was the most common diagnosis captured by the 'both PAEDT & PAH' category. The ten most common acute care diagnoses were similar when comparing all transfers to those that resulted in hospitalization, with the exception of adjustment of implanted device and weakness/fatigue (overall transfers) and gastrointestinal bleeding and cerebrovascular accident diagnoses (transfers resulting in hospitalization).

Table 5.1 Patient and acute care transfer-level characteristics by avoidability outcome measure

	All transfers	PAEDT Only	Both PAEDT & PAHs	PAH Only	Unavoidable transfers
Episodes N (%)	**1,233 (100)**	**281 (22.8)**	**143 (11.6)**	**24 (1.9)**	**785 (63.7)**
Female N (%)	620 (50.3)	151 (53.7)	76 (53.1)	11 (45.8)	382 (48.7)
Age at the time of the episode N (%)					
<65	139 (11.3)	27 (9.6)	10 (0.7)	6 (25.0)	96 (12.2)
65-74	154 (12.5)	36 (12.8)	15 (10.5)	1 (4.2)	102 (13.0)
75-84	345 (28.0)	87 (31.0)	38 (26.6)	8 (33.3)	212 (27.0)
85-94	495 (40.1)	113 (40.2)	61 (42.7)	8 (33.3)	313 (39.9)
>95	100 (8.1)	18 (6.4)	19 (13.3)	1 (4.2)	62 (7.9)
Time of ED arrival (work shift) N (%)					
07:59 AM – 04:00 PM (day)	598 (48.5)	144 (51.2)	67 (46.9)	10 (41.7)	377 (48.0)
04:01 PM – 12:00 AM (evening)	480 (38.9)	102 (36.3)	55 (38.5)	13 (54.2)	310 (39.5)
00:01 AM – 08:00 AM (night)	155 (12.6)	35 (12.5)	21 (14.7)	1 (4.2)	98 (12.5)
Day of the episode N (%)					
Weekday (Mon-Fri)	932 (75.6)	216 (76.9)	110 (76.9)	15 (62.5)	591 (75.3)
Weekend/Holiday	301 (24.4)	65 (23.1)	33 (23.1)	9 (37.5)	194 (24.7)
CTAS triage acuity at arrival N (%)					
Level I: Resuscitation	130 (10.5)	13 (4.6)	21 (14.7)	3 (12.5)	93 (12.5)
Level II: Emergent	391 (31.7)	47 (16.7)	70 (49.0)	7 (29.2)	267 (34.0)
Level III: Urgent	505 (41.0)	67 (23.8)	43 (30.1)	12 (50.0)	383 (48.8)
Level IV: Less urgent	201 (16.3)	151 (53.7)	9 (6.3)	2 (8.3)	39 (5.0)
Level V: Non urgent	6 (0.5)	3 (1.1)	0 (0.0)	1 (0.0)	3 (0.4)
Length of Stay (Mean ± SD)					
ED (hours)	26±19	20±17	37±18	34±19	26±19
Hospital (days)	9±15	NA	8±8	10±7	11±18
Discharge disposition N (%)					
Returned to LTC home	632 (51.3)	252 (89.7)	0 (0.0)	0 (0.0)	380 (48.4)
Hospitalized	533 (43.2)	13 (4.6)	143 (100.0)	24 (100)	353 (45.0)
Died	37 (3.0)	4 (1.4)	0 (0.0)	0 (0.0)	33 (4.2)
Institution transfer	29 (2.4)	12 (4.3)	0 (0.0)	0 (0.0)	17 (2.2)
Left without being seen	2 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.3)

PAEDT: Potentially Avoidable Emergency Department Transfers; PAH: Potentially Avoidable Hospitalizations; ED: Emergency Department; LTC: Long-Term Care

Table 5.2 Long-term care home reasons for transfers and acute care diagnoses by avoidability outcome

		PAEDT Only	Both PAEDT & PAH	PAH Only (Walsh)	Unavoidable transfers
ALL TRANSFERS (N=1,233)	**N (%)**	**281 (22.8)**	**143 (11.6)**	**24 (1.9)**	**785 (63.7)**
Ten most common LTC home transfer reasons					
Shortness of breath	234 (19.0)	42 (14.9)	70 (49.0)	4 (16.7)	118 (15.0)
Altered level of consciousness	125 (10.1)	13 (4.6)	18 (12.6)	4 (16.7)	90 (11.5)
General weakness	75 (6.1)	13 (4.6)	8 (5.6)	-	54 (6.9)
Medical device problem	72 (5.8)	43 (15.3)	1 (0.7)	-	28 (3.6)
Lower extremity injury	51 (4.1)	13 (4.6)	-	-	38 (4.8)
Abnormal lab values	45 (3.6)	5 (1.8)	3 (2.1)	3 (12.5)	34 (4.3)
Head injury	38 (3.1)	8 (2.8)	-	1 (4.2)	29 (3.6)
Abdominal pain	37 (3.0)	8 (2.8)	4 (2.8)	-	25 (3.2)
Chest pain (cardiac features)	37 (3.0)	3 (1.1)	2 (1.4)	1 (4.2)	31 (3.9)
Cough / Congestion	31 (2.5)	10 (3.6)	7 (4.9)	-	14 (1.8)
Ten most common principal ED diagnoses					
Pneumonia	80 (6.5)	26 (9.3)	54 (37.8)	-	-
Aspiration pneumonia	76 (6.2)	2 (0.7)	-	3 (12.5)	71 (9.0)
Congestive heart failure	66 (5.4)	25 (8.9)	41 (28.7)	-	-
Septicemia	55 (4.5)	-	-	1 (4.2)	54 (6.9)
Adjustment of implanted device	51 (4.1)	33 (11.7)	-	-	18 (2.3)
Urinary tract infection	45 (3.6)	33 (11.7)	12 (8.4)	-	-
Shortness of breath	40 (3.2)	4 (1.4)	-	2(8.3)	34 (4.3)
Weakness/fatigue	35 (2.8)	4 (1.4)	-	-	31 (3.9)
COPD exacerbation	34 (2.8)	15 (5.3)	19 (13.3)	-	-
Closed hip fracture	30 (2.4)	2(0.7)	-	-	28 (3.6)
HOSPITALIZATIONS (N=533)	**N (%)**	**13 (2.4)**	**143 (26.8)**	**24 (4.5)**	**353 (66.2)**
Ten most common LTC home transfer reasons					
Shortness of breath	160 (30.0)	3 (23.1)	70 (49.0)	4 (16.7)	83 (23.5)
Altered level of consciousness	72 (13.5)	2 (15.4)	18 (12.6)	4 (16.7)	48 (13.6)
General weakness	39 (7.3)	8 (5.6)	8 (5.6)	-	29 (8.2)
Lower extremity injury	24 (4.5)	-	-	-	24 (6.8)
Abdominal pain	18 (3.4)	1 (7.7)	4 (2.8)	-	13 (3.7)
Abnormal lab values	16 (3.0)	-	3 (2.1)	3 (12.5)	10 (2.8)
Vomiting and/or nausea	15 (2.8)	-	3 (2.1)	2 (8.3)	10 (2.8)
Chest pain (cardiac features)	12 (2.3)	-	2 (1.4)	1 (4.2)	9 (2.5)
Cough / Congestion	12 (2.3)	-	7 (4.9)	-	5 (1.4)
Cough and fever	12 (2.3)	1 (7.7)	6 (4.2)	-	5 (1.4)
Ten most common hospital diagnoses*					
Pneumonia	61 (11.4)	-	56 (39.2)	5 (20.8)	-
Septicemia	58 (10.9)	-	-	-	58 (16.4)
Aspiration pneumonia	51 (10.9)	-	-	-	51 (14.4)
Congestive heart failure	40 (7.5)	-	38 (26.6)	2 (8.3)	-
Closed hip fracture	26 (4.9)	-	-	-	26 (7.4)
COPD exacerbation	19 (3.6)	-	19 (13.3)	-	-
Shortness of breath	14 (2.6)	2 (15.4)	-	-	12 (3.4)
Urinary tract infection- urosepsis	14 (2.6)	-	13 (9.1)	1 (4.2)	-
Gastrointestinal bleeding	13 (2.4)	-	-	-	13 (3.7)
Cerebrovascular accident	12 (2.3)	1 (7.7)	-	-	11 (3.1)

*5 admitted transfers with missing hospitalization diagnoses were replaced with ED diagnoses.
LTC: Long term care; PAEDT: Potentially Avoidable Emergency Department Transfers; PAH: Potentially Avoidable Hospitalizations.

5.6 Discussion

We investigated potentially avoidable ED transfers and hospitalizations for conditions that are potentially 'clinically manageable' in the context of the Quebec LTC setting. Our results indicate that the PAEDT measure is an essential metric in terms of its ability to capture potentially avoidable transfers from LTC homes. PAEDT and PAH proportions in our Quebec sample were comparable to the rest of Canada. While current mechanisms to investigate potentially avoidable transfers to acute care from LTC homes require improvement (especially in Quebec), we have established that ED databases can be used to achieve this end with some limitations.

In the LTC avoidable transfers literature, PAHs have historically been the more commonly used outcome measure.[27-29] Hospitalizations have a significant impact on both clinical and cost trajectories for this resident population upon return to the LTC, such that preventive strategies at the LTC- level are required.[30] The decision to hospitalize following admission to the ED, however, involves factors outside of LTC staff control (e.g., availability of acute care beds, ED care practices and norms, health status changes in the ED, or ED staff perceptions of LTC capability).[31] Our study underscores the importance of PAEDT quantification regardless of subsequent hospitalizations, as PAEDTs reflect complex LTC transfer decision-making processes undertaken by LTC stakeholders. Indeed, ED visits by LTC home residents that do not result in subsequent hospitalization are sometimes defined as being 'potentially avoidable', while those resulting in admission are considered 'less likely avoidable'.[23,32]

In our recent systematic scoping review of interventions aimed at reducing transfers from LTC, we found that reported outcomes were almost always limited to all transfers (i.e., regardless of avoidability specification),[33-41] while only three studies[42-44] (representing 3.3% of the review study sample) measured PAEDTs as their primary outcome.[45] These three studies adapted the ambulatory care sensitive condition approach in different ways, which speaks to the need for harmonizing definitions. More to the point, however, is the fact that PAEDTs are very seldomly measured in the literature, perhaps due to challenges with their measurement.

If the goal is to effect change, it is necessary to target the source and examine relevant outcomes. For instance, we found fewer urinary tract infection-related PAEDT Category 1 transfers in Quebec compared with those in the rest of Canada, which may indicate some locally established best practices. In contrast, the frequency of transfers attributable to implanted device malfunction was particularly notable in our sample. Though this finding may indicate an area for

local LTC improvement, without further detail, it is hard to know whether this was due to higher prevalence of using such devices or the achievability of 'fixes' outside the hospital setting. In the rest of Canada, falls was the most frequent condition, accounting for 25% of all PAEDT Category 2 transfers.[23] In our dataset, the "injury and fracture" category captured conditions such as head injury, joint dislocations, and bone fractures as "injury and fracture", for which the underlying reasons might have been falls.

Finally, the Walker PAH definition considers transfers for 'manageable' as well as 'preventable' conditions (e.g., septicemia and closed hip fracture) as being potentially avoidable. It is our contention that the concepts of 'preventing' vs. 'managing' acute conditions in LTC should be investigated separately, given that they represent distinct sets of clinical activities within an exposure-outcome timeline. This approach would yield more focused and effective strategies to improve LTC quality of care.

5.6.1 Strengths and limitations

The main strength of our study is that we conducted a thorough investigation of PAEDTs both with and without subsequent hospitalization from the LTC setting. Our use of the ED database (as opposed to LTC census data) facilitated the exclusion of planned hospital visits (e.g., appointments with specialists, elective surgeries) from our sample. This was also the first study, to our knowledge, to investigate this issue in one metropolitan city hospital in the province of Quebec. Generalizability of our results to all LTC homes, however, may be limited. Choosing another Canadian province or city as a comparator was not possible due to the lack of available data, and our sample does not represent private LTC homes.

There were no reliable registries of emergency transfers recorded by LTC homes during the study period, which led us to use the MedUrge electronic tracking and flow system to identify acute care transfers. This approach generated some limitations. First, the tertiary care hospital for which this database was available captured 75% of all acute care transfers from our participating LTC homes. While we do not believe that there would be any systematic differences in terms of the characteristics of transfers sent to other hospitals during this period, it is possible that this could be the case. In addition, use of MedUrge had its own specific limitations. Firstly, principal ED diagnoses are recorded without the use of a standardized coding system. As such, we were unable to report a list of codes used to classify outcome measures. Furthermore, given that there is no

post-hoc linkage with the hospitalization database, we did not have access to the more precise list of diagnosis codes for residents who were subsequently admitted to hospital.

Our study included all 7 LTC homes in the Network. We opted not to exclude data emanating from the smallest site that has both dedicated LTC home and rehabilitation beds, as the majority of transfers from this site are known to emanate from the LTC resident population. We had originally planned on conducting detailed resident chart reviews to document specific transfer details, fill in missing information, and validate residents from this smallest site as belonging to the LTC bed population. The advent of the COVID-19 pandemic,[46] however, prohibited researcher access to LTC homes in the province of Quebec during 2020, and this phase of our study was unfortunately cancelled. It is, therefore, possible that as much as 3% of our transfer episode study sample has been misclassified as emanating from LTC residents. Although we could not conduct our planned chart reviews due to COVID-19 pandemic-related research restrictions, we were provided access to 16 charts corresponding to 23 transfers from 2 participating homes. This limited access allowed us to verify that low-acuity transfers due to 'adjustment and management of implanted devices' pertained to issues with percutaneous endoscopic gastrostomy, urinary catheter, peripherally inserted central catheter lines, or nephrostomy tubes.

5.6.2 Future directions

An important issue not considered in this study pertains to transfers that contravene resident advance directives. A 2019 Canadian study reported that about half of LTC residents who were transferred to hospital had explicitly declared advance directives to the contrary[7] and, in 2016, CIHI reported that among LTC residents with a "do not hospitalize" directive, 7% were hospitalized.[8] Factors relating to the role of non-clinical stakeholders in the decision making process should be considered, and future studies that measure avoidable transfers from this setting should consider including transfers that contravene advance directives in their results.

Although the ambulatory care sensitive condition approach can provide a literature-based portrait of the prevalence of potentially avoidable acute care transfers, it does not take into account LTC facility-level factors such as staffing characteristics, diagnostic testing and treatment capabilities, affiliation with acute care hospitals, or regional primary care availability.[1,47] Indeed, the term 'potentially' acknowledges comorbidity, disease severity, or other risk factors that may necessitate transfers.[25] We are currently designing a large observational study (covering 1,200

LTC resident beds over a 3-year period) to conduct an in-depth analysis regarding the match between theory and clinical realities on the ground. This will be achieved via detailed resident chart reviews and a post-hoc analysis of the underlying reasons for transferring as opposed to treating residents on site. Using these results, we will then engage front-line staff in deliberative dialogues to explore key transfer scenarios with the aim of identifying transfer-reducing strategies.

Another area of future study should include an analysis of LTC reasons for transfer and eventual ED and hospital diagnoses to better understand the trajectory of acute events resulting in the decision to transfer. Last, residents younger than 65 years-old contributed to 11% of all transfers in our study. This group of residents is usually characterized by individuals who are developmentally disabled or who have other conditions that render them dependent for their activities of daily living. Although these younger residents may have different acute problems and recovery trajectories, functional impairment requiring around the clock assistance for activities of daily living is a common characteristic of those residing in LTC homes. In fact, acute care transfer rates were reported to be the highest among residents younger than 60 years-old.[48] We recommend that future studies include all LTC residents and report detailed individual-level data prior to transfers, e.g., specific signs and symptoms, dementia severity, or standardized measure of frailty. These approaches would promote developing person-centered strategies for this population.

5.7 Conclusions

Understanding the circumstances and reasons for acute care transfers from LTC homes is important for improving care in this milieu. We demonstrated that the quantification of potentially avoidable ED transfers with or without hospitalizations is an essential quality assurance measure for the frail LTC home population. Our findings have implications for this complex care setting that involve not only LTC practice and policy, but also practicing geriatricians and other stakeholders involved in the management of transitions between care settings in Canada. This study was also the first time potentially avoidable ED transfers and hospitalizations were investigated in-depth in the province of Quebec. Improved mechanisms for monitoring potentially avoidable acute care transfers should be developed to inform interventions to reduce them in Quebec and beyond.

5.8 Acknowledgements

5.8.1 Conflict of interest

We have read and understood the Canadian Geriatrics Journal's policy on disclosing conflicts of interest and declare that we have none.

5.8.2 Author contributions

Deniz Cetin-Sahin led the conception and design, analysis, interpretation of data, and the drafting, revisions, and final approval of the article. Machelle Wilchesky led to acquisition of data, contributed to the conception and design, interpretation of data, drafting, revisions and final approval of the article. Mark Karanofsky, Greta G. Cummings, and Isabelle Vedel contributed to interpretation of data, drafting, revision and final approval of the article.

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5.8.3 Sponsor's role

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5.8.4 Ethics approval

The Network's Research Review Office (Medical-Biomedical Research Ethics Committee) approved the study (Project 2019-1580) (Appendix A).

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5.10 The RECORD statement

Checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	117 117	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	117 117 N/A
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	118		
Objectives	3	State specific objectives, including any prespecified hypotheses	118,119		

Methods					
Study Design	4	Present key elements of study design early in the paper	119		
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	119.120		
Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case	119,120	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	119 N/A N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	120,121	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	120

Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	119-121		
Bias	9	Describe any efforts to address potential sources of bias	119,122,132		
Study size	10	Explain how the study size was arrived at	120		
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	121,122		
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	122 N/A 119,122,132 N/A 122		

Data access and cleaning methods		..	..	RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	119 4
Linkage		..	..	RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	N/A
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram	6 N/A N/A	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	119
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)	Table 5.1 122 Table 5.2 N/A		

Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures	122-129		
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A N/A N/A		
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	125		
Discussion					
Key results	18	Summarise key results with reference to study objectives	130,131		
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	131,132	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	131,132
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses,	130-133		

		results from similar studies, and other relevant evidence			
Generalisability	21	Discuss the generalisability (external validity) of the study results	131		
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	134,14		
Accessibility of protocol, raw data, and programming code		..	..	RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	N/A

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; doi:10.1371/journal.pmed.1001885.t001.

CHAPTER 6: MONTE CARLO DATA SIMULATIONS TUTORIAL: A METHOD TO INFORM THE DESIGN AND ANALYSIS OF OBSERVATIONAL STUDIES ILLUSTRATED USING AN EXAMPLE FROM THE LONG-TERM CARE SETTING (MANUSCRIPT 3)

6.1 Preamble

Reducing 'potentially avoidable' acute care transfers is a benchmark to improving the quality of care in LTC homes. Research on the impact of interventions aimed at reducing 'potentially avoidable' acute care transfers from LTC homes has been inconclusive. Although randomized controlled trials are considered as the gold-standard for evidence-based medicine, they are expensive, time-consuming, and often take place under artificial exposure/treatment conditions that are not replicable in real-world settings. Furthermore, in this context, a trial would likely have to be a cluster randomized trial for feasibility purposes (implementation of an intervention at the LTC home level). These trials require significant resources, which is why, the use of advanced observational study methods that rely on retrospective data can be advantageous. Current developments in causal inference framework methods provide alternative approaches for the reduction of confounding bias and precision improvement precision in observational studies, but these methods have rarely been applied in this clinical context.

Causal processes that drive behaviors (known as "causal ground truth") are almost never known or observable within complex organizational systems and processes. As such, data simulations are another means by which confounding bias can be reduced. They involve estimating intervention effects via exploration of how bias, errors, and variation across settings affect inference. Simulation studies, especially those using Monte-Carlo methods, are common in statistical research. While their application is common in certain areas of clinical research (e.g., pharmacoepidemiology), they are less commonly applied to others. This limited uptake in applied research is likely explained by the required advanced statistical know-how and programing skills required to successfully implement them.

To address these two gaps in the literature, I designed this third substudy with a view to informing future observational study designs that would apply a causal inference framework to estimate the average causal effect of an exposure of interest on a contextually and clinically meaningful outcome of interest. To do so, in this third substudy, I used acute care transfers from

the LTC setting as a motivating example. Based on the results from Manuscripts 1 and 2, I prioritized and operationalized the specific exposure and outcome measures and herewith proposed a data simulations tutorial (Manuscript 3) accordingly.

Findings from the systematic scoping review (Manuscript 1) assessing interventions aimed at reducing 'potentially avoidable' acute care transfers from LTC homes informed my exposure selection both conceptually and methodologically. Conceptually, findings from this review indicated that the set of studies evaluating advance care planning (ACP) interventions had some limitations: 1) None of the 12 studies measured 'potentially avoidable' acute care transfers as the primary or even secondary outcomes; 2) Most were of poor quality; 3) Of the 3 that measured ED transfers (and not subsequent hospitalization) as outcomes, 2 had small sample sizes with inconclusive results, whereas the large study did demonstrate a statistically significant reduction; and 4) Interventions within the advance care planning category were less likely to rely on expanding human resources, something which is often infeasible, as compared to the other intervention categories. For all of these reasons, ACP was identified as a promising exposure candidate for our future observational study, which is why its application is explored here. Methodologically, ACP meets the criterion of being identified in real-world settings since it is a care process that already exists within the set of LTC homes where the observational study is planned to be conducted. In addition to identifying an exposure, Manuscript 1 (the review) informed my selection of other variables presented in the causal diagram.

Findings from Manuscript 2 (the cross-sectional study) operationalized the target outcome measure as being potentially avoidable transfer outcome measures (emergency department transfers vs. hospitalizations) for conditions that are 'clinically manageable' in Quebec LTC home setting. As such, I have prioritized emergency transfers (and not subsequent hospitalizations) as the primary outcome measure for the causal diagram.

In the following manuscript, I illustrated the usefulness of conceptualizing a causal diagram that encodes known or suspected relationships between measured and unmeasured factors, advanced care planning (ACP, the exposure of interest) and their impact on potentially avoidable ED transfers (the primary study outcome). I demonstrated how encoded information representing realistic study scenarios can be used to design and implement Monte-Carlo simulation analyses using standard statistical software that enables repeated simulation. The generated knowledge will inform the analysis framework and the assumptions for estimating average causal effects in a future

observational study. This methodological model can be adapted to future studies aiming to identify proactive models of person-centred care that might causally effect clinically meaningful outcomes in different settings.

The following manuscript will be submitted to a peer-reviewed journal (The BMJ, Research Methods and Reporting).

Title: Monte Carlo data simulations tutorial: A method to inform the design and analysis of observational studies illustrated using an example from the long-term care setting

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6.2 Abstract

Randomized controlled trials are expensive, time-consuming, and usually take place under ideal exposure/treatment conditions that are not replicable in real-world settings. The use of advanced observational study methods for health policy can be sometimes more advantageous. Although Monte-Carlo simulation studies are an established approach in statistical methodological research, they are not commonly applied for informing the design and inference-analytical approach of clinical observational studies. The goal of this paper is to demonstrate the utility of Monte-Carlo data simulations to inform the design and analysis of observational studies in clinical care settings. Our objectives are to: 1) describe Monte-Carlo data simulations; 2) provide a step-by-step guide for implementing a Monte-Carlo study using standard statistical software that enables repeated simulation of realistic study scenarios; and 3) discuss the limitations of data simulations and how to mitigate them. We use the example of the long-term care home setting to illustrate the usefulness of causal diagrams for encoding known or suspected relationships between measured and unmeasured factors, an exposure of interest (advance care planning) and a primary study outcome (potentially avoidable emergency department transfers).

6.3 Introduction

High-quality of evidence is required to develop or upscale sound healthcare policies. Although randomized controlled trials (RCTs) are considered as the gold-standard for evidence-based

medicine, they are expensive, time-consuming, and often take place under artificial exposure/treatment conditions that are not replicable in real-world settings.[1,2] In addition, in certain settings, a cluster RCT design would be necessary (i.e., implementation of an intervention at the clinic, unit, or hospital level) for feasibility purposes that would require significant resources.[3] The use of advanced observational study methods that rely on retrospective data can therefore be advantageous in many circumstances.[4] Causal inference methods that use data emanating from observational studies can provide valid and reliable real-world evidence, which is particularly valuable for clinical situations that are unlikely to be tested using RCTs.[4] According to a Cochrane review, there is little systematic disagreement between results emanating from observational studies as compared with RCTs.[5] There are, however, two important challenges arising from observational studies that are designed to assess the effects of exposures or interventions on outcomes.

First, observational studies are prone to confounding bias, (i.e., the systematic distortion of the estimated effects by factors that are causally linked to both the exposure and outcome of interest).[6] If known confounding variables are measured, conditional (covariate-adjusted) or marginal (inverse probability of exposure-weighted) statistical models can be applied to reduce confounding bias when estimating respective exposure effects.[7] The multivariable nature of such models, however, comes at the cost of increased complexity and uncertainty in the planning of the study and method(s) chosen to adjust for covariates to best answer the etiological research question. Observational studies, however, commonly use multiple administrative healthcare services claim databases which may lack detailed information about individual data.[8] A major challenge for the proper planning of the study and its primary inference approach is its sensitivity with respect to a misspecified confounder-adjustment (or weighting) approach as well as the omnipresent issue of missing data occurring not-completely at random.[9] Analytical approaches such as bias formulas and confounding functions exist that can help determine the potential impact of missed confounders and/or differential drop-out on the accuracy of effect estimates. However, these standard formulas typically refer to one single confounding variable and do not accommodate more complex multivariable data structures.[10]

From a study design perspective, a second challenge pertains to determining the minimum required sample size, to achieve a desired level of statistical power, a task usually conducted using basic formulas. Most standard sample size formulas require the user to only specify group

allocation ratios of the exposure, anticipated effect sizes (specific to the distribution of the outcome) and desired Type I and Type II error levels. Many online tools and text-book formulas exist that facilitate the computation of required sample sizes given these few parameter inputs.[11] The latter, however, is challenging as the precision of the covariate-adjusted (or weighted) effect estimate will depend on the multivariate distribution of covariates being considered. Standard formulas for determining minimum detectable effect sizes, required number of samples, or statistical power may not always be applicable and can lead to ill-informed design-recommendations[10] – even though the necessity of power calculations for causal methods is now being discussed.[12]

Simulation studies, especially those using Monte-Carlo methods, offer solutions to the above-mentioned challenges by enabling the emulation of data structures that mirror, within a given context, understanding about how covariates, exposures and outcomes are causally inter-related.[13] This in turn enables researchers to investigate, before a study is initiated, a large variety of scenarios that are consistent with the theoretical understanding of the complex nature of the etiological question in hand. Using modern computers and software, many thousand pseudo studies can be generated within minutes that help to assess the sensitivity of results with respect to design choices, data-analytical parameters, and violations of critical structural assumptions.[14,15] While Monte-Carlo simulation studies are an established approach in statistical methodological research, and while their application is common in certain areas of clinical research (e.g., pharmacoepidemiology), they are less commonly applied to others (e.g., to inform clinical study planning).[10] This limited uptake in applied research is likely explained by the required advanced statistical know-how and programing skills required to successfully implement them.

The overarching goal of this paper, therefore, is to demonstrate the utility of Monte-Carlo data simulations to inform the design and analysis of observational studies in clinical care settings. To achieve this goal, our specific objectives are to:

1) Describe Monte-Carlo data simulations;

2) Provide step-by-step guidance for Monte-Carlo study implementation using standard statistical software that enables repeated simulation of realistic study scenarios; and

3) Discuss the limitations of data simulations and how to mitigate them.

For illustration, the example of designing an observational study in the context of the long-term care (LTC) setting to measure impact of an exposure of interest (advance care planning) on

the primary study outcome (potentially avoidable emergency department transfers) is used. The utility of causal diagrams to encode known or suspected relationships between measured and unmeasured factors, the exposure of interest, and outcomes is presented. Scenarios that provide important insights on the appropriateness of study design aspects such as sample size considerations and inferential methods to be applied for estimating exposure effects with sufficient accuracy and precision are illustrated.

6.4 Objective 1: What are Monte-Carlo data simulations?

Data simulation is an approach frequently used in quantitative methodological research to assess the performance of inference methods, i.e., statistical estimators, that employ data from study samples to determine population quantities.[16] Such quantities include prevalence or incidence rates, means, proportions, or contrasts (differences and ratios) in these quantities between subpopulations of interest.[17]

Simulation studies can be categorized as being either unreplicated (where only one data set is simulated[18]) or replicated (where multiple data sets are simulated, and known as 'Monte Carlo methods' or 'Monte Carlo simulation studies').[16] Monte Carlo simulations constitute a broad and widely established subclass, and their defining feature is the application of repeated random sampling from known distributions to generate data that encodes prior knowledge or assumptions regarding the phenomenon (e.g., exposure – outcome relationships under study).[14]

Beyond their use for evaluating and selecting analytical strategies for complex data, simulation studies can also be useful for the purpose of sensitivity analyses.[19] This especially applies in settings where conventional quantitative bias analysis methods are not applicable.[20] This shift from analytical (hypothesis-driven) bias-assessment approaches to data-driven approaches aligns with the increasing popularity of machine learning, rather than conventional statistical modeling and testing paradigms.[21, 22]

In an analytical approach, confounder control essentially involves making decisions based on substantive knowledge (or assumptions) regarding the underlying data-generating mechanisms.[21] In practice, however, researchers sometimes formulate a 'null hypothesis' that serves as a basis for evaluating the possibility of randomness of observed phenomena (e.g., group differences or associations) in their sample data. If observations are more extreme than that which would be expected under the null hypothesis, researchers may favour an alternative hypothesis.

However, these decisions are often made without having much knowledge of the underlying causal structures and without knowing for certain whether adjustment for particular covariates will change the magnitude (or even direction) of the observed difference or association.[23]

A data-driven approach such as a Monte-Carlo simulation, however, requires a much larger set of inputs and considerations.[23] In addition, the respective statistical program must enable repeated data simulation using random (yet replicable) data-generating processes (so called 'pseudo-random' sampling[24]). In addition, this program must facilitate the extraction of effect estimates which are then stored and further processed to compute performance statistics such as average bias, type I/II error rates, and coverage.[16] For each variable embedded in the theoretical structural model, assumptions must be made regarding its distribution (e.g., its prevalence or its expected value and variance as well as how these distribution characteristics depend on other variables). This process is known as 'probabilistic bias analysis' in which distributions to the bias parameters are assigned instead of focusing on fixed sets of values.[20]

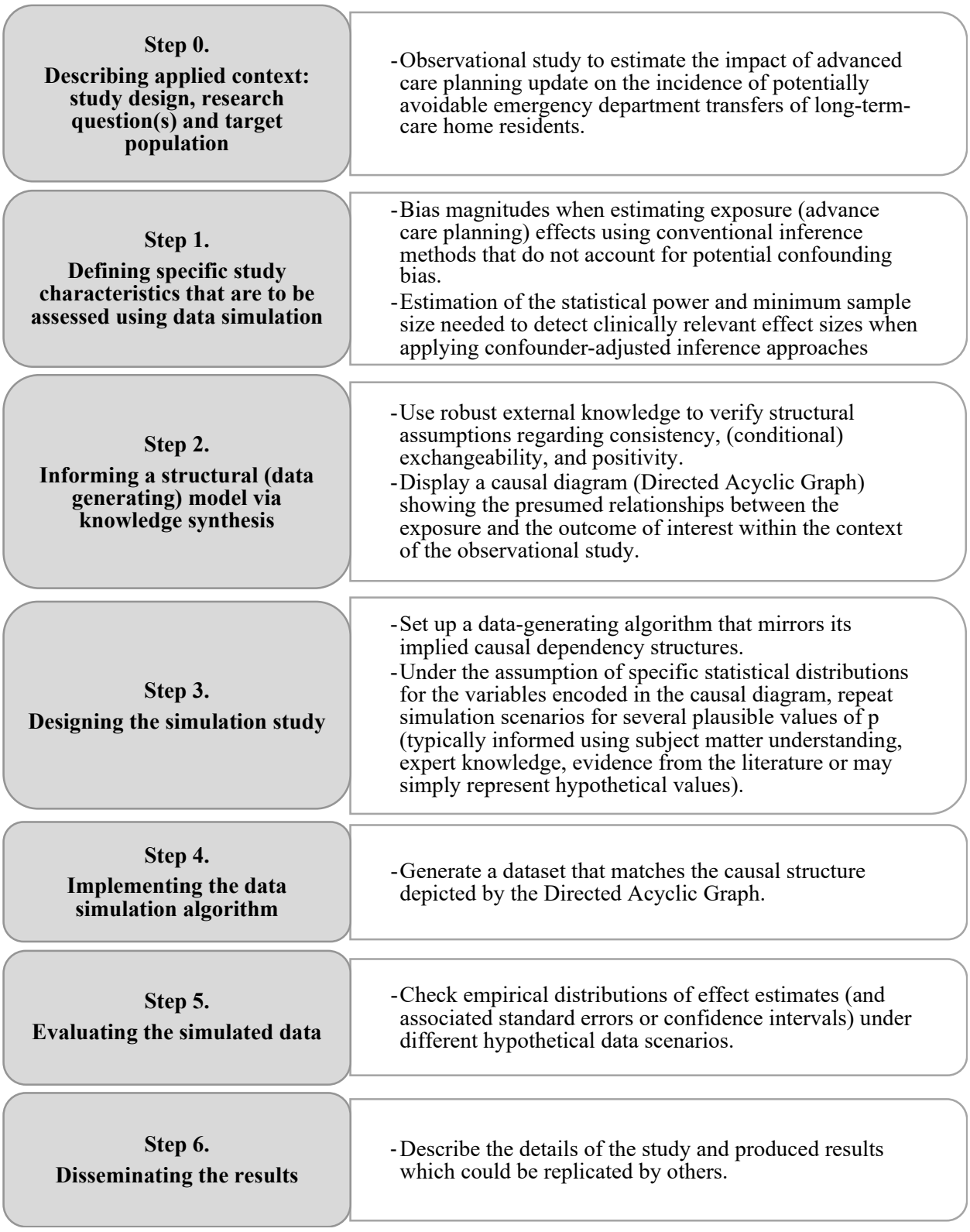
Finally, simulation approaches offer a flexible alternative for informing research study design aspects in complex settings that may not conform to conventional sample size or power equations used for their estimation.[15] For example, in multiple treatment interventions, one treatment may be deployed at the group level while a second treatment at the individual level.[25] In addition, when multivariable approaches are used to estimate confounder-adjusted (conditional) or weighted (marginal) exposure or intervention effects, the number, distributions, and correlation structure of covariates are important determinants for the efficiency of the estimator. For these reasons, standard formulas for sample size or power calculations do not adequately mirror such complexities.[15]

6.5 Objective 2: Tutorial: How to set up a Monte-Carlo data simulation to inform an observational study design

There are several basic steps required for conducting a sound and replicable simulation study. These steps include describing the applied context, defining the specific study characteristics, informing a structural model via knowledge synthesis, designing the simulation study, implementing the data simulation algorithm, evaluating the simulated data, and disseminating the results.[17] We demonstrate each of these steps using a motivating real-world example of an observational study that assesses the potential role of advance care planning (ACP) on the

prevention of potentially avoidable emergency department (ED) transfers by persons living in LTC homes (see Supplemental file 1 for definitions). Figure 6.1 provides a generic scheme that summarizes the setup of a simulation study into steps.

Figure 6.1 Step-by-step generic scheme for data simulations



6.5.1 Step 0 – Describing applied context: study design, research question(s) and target population

The primary concern of our overarching research question is the incidence rate of potentially avoidable ED transfers from LTC homes, which are care settings that provide 24-hour nursing and personal care to persons with complex health needs or functional deficits/chronic conditions.[26] Given their frail nature, LTC residents are often transferred to the ED during episodes of acute clinical decline. Some of these transfers are potentially avoidable as they stem from conditions that are theoretically and ideally manageable onsite (e.g., pneumonia).[27] Potentially avoidable transfers both may result in adverse outcomes (e.g., nosocomial infections, delirium, pressure ulcers, and other nosocomial comorbidity), and they also represent inefficient allocation of healthcare resources. Reducing these transfers is therefore a quality benchmark.[28]

While a body of literature reporting on the efficacy/effectiveness of interventions (both experimental and non-experimental) aimed at reducing these transfers exists, the certainty of evidence is unclear due to clinical, methodological, and statistical heterogeneity of these studies.[29] Although pragmatic trial approaches have been receiving attention within the context of LTC homes, they too come with complexities.[25] Current developments in causal inference framework methods provide alternative approaches for the reduction of confounding bias and precision improvement in observational studies, but these methods have rarely been applied in this clinical context.[30] To date, only two studies have attempted to apply causal inference framework for this topic in general. These studies, however, did not investigate ACP as the exposure and measured only subsequent hospitalization (and not the transfers per se) as outcomes from LTC.[31,32] Advance care planning represents a compelling intervention/exposure candidate for observational studies aimed at reducing acute care transfers from LTC settings as it explicitly involves the key stakeholders involved in the transfer decision-making process. It is difficult to compare ACP intervention efficacy/effectiveness, however, as there is substantial clinical heterogeneity, the number of high-quality studies is limited, and most measured subsequent hospitalizations rather than ED transfers as outcomes.[29]

Given that modern causal inference methods informed by data simulations offer a potentially effective alternative to deal with these complexities, we aimed to design an observational study to estimate the impact of documented ACP updates (a real-world exposure existing under regular condition, i.e., non-experimental) on the incidence of potentially avoidable

ED transfers (outcome of interest, measured during the 12 months follow-up or until death) among LTC residents who were 65 years and older and diagnosed with dementia at the LTC admission. We operationalized ACP with the help of key LTC informants (i.e., defined as having at least one documented ACP meeting that has taken place between physicians and residents and/or their families/representatives within the year after the LTC admission). We used a well-defined potentially avoidable ED transfer measure proposed by Canadian Institute for Health Information (see precise definitions in Supplemental file 1).[33]

6.5.2 Step 1 – Defining specific study characteristics that are to be assessed using data simulation

As observational studies are prone to considerable confounding bias when estimating exposure effects, a primary concern is the assessment of the magnitude of potential biases. To do so, we compute performance statistics such as average bias, type I/II error rates and coverage. and performance of alternative analytical confounder-adjustment approaches (conventional multivariable regression vs inverse-probability weighting approaches). In addition, given the multivariable nature of analytic approaches required for estimating covariate-adjusted exposure effects, a co-primary concern in this observational study is to detect clinically relevant effect sizes when applying multivariable inference approaches. To address this concern, we estimate the statistical power and minimum sample size needed.

6.5.3 Step 2 – Informing a structural (data generating) model via knowledge synthesis

Causal research questions aim to answer what effect modifiable exposure(s) may have on one specific outcome. When adapting a valid causal inference framework, investigators must be conscious of fundamental assumptions needed to mimic levels of unbiasedness close to a RCT. These assumptions are well-defined and are at least partially verifiable using robust external knowledge. Concretely, they are referred to as structural assumptions regarding consistency, (conditional) exchangeability, and positivity.[34]

The consistency assumption requires that the outcome observed among exposed and unexposed individuals truly reflects the outcome under the respective exposure status. Put in simple terms: the consistency assumption requires that the exposure be well-defined and not have multiple versions – ‘no misclassification, neither of the exposure nor the outcome’ exists for all

individuals in the study. Non-adherence, non-compliance, or exposure cross-over, for example, would invalidate this assumption.

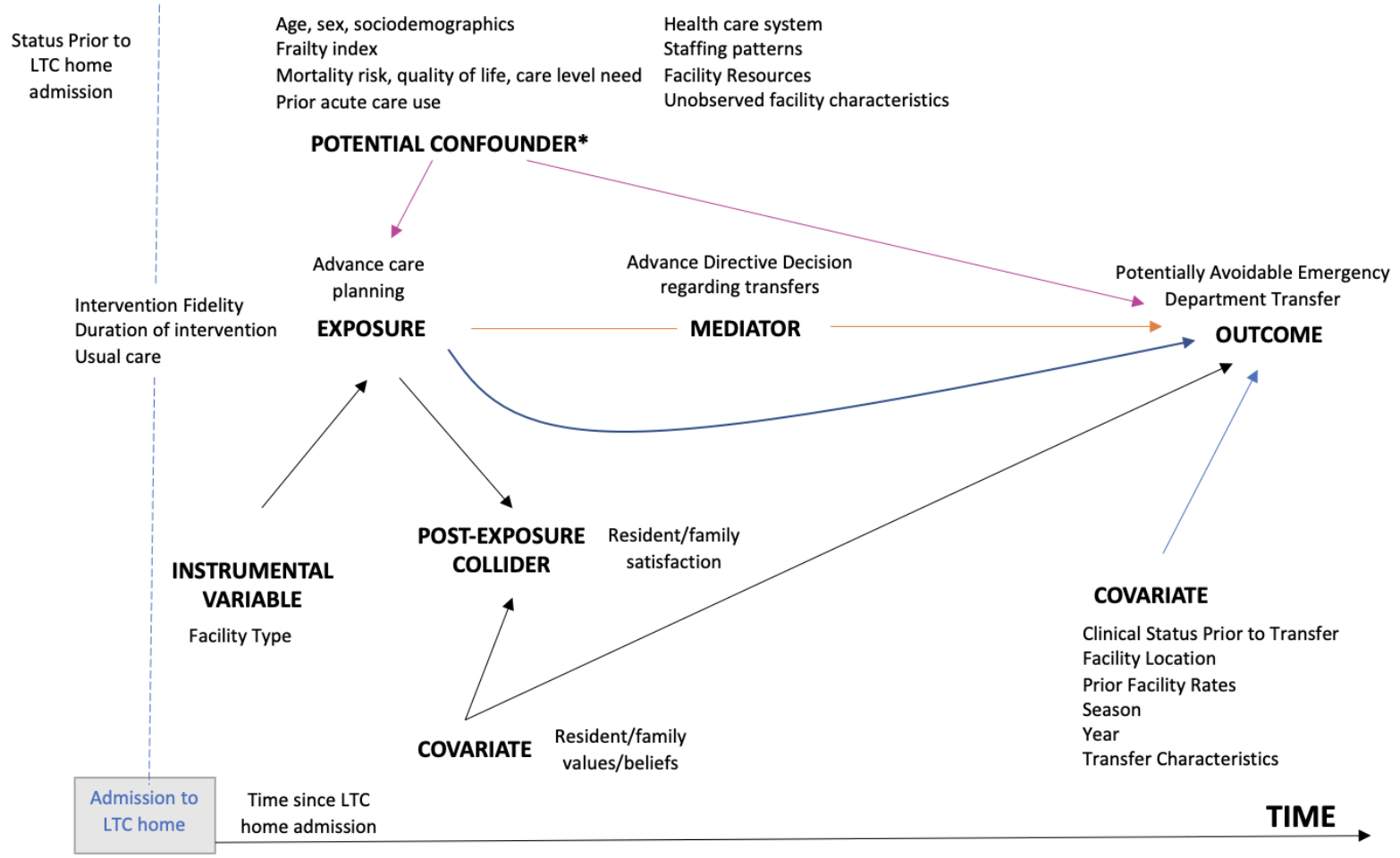
The conditional exchangeability assumption requires that common causes of the exposure and the outcome (i.e., confounding variables, enough to ensure that the counterfactual average risks are the same), are being measured and appropriately accounted for when estimating the exposure effect.[35] Both, covariate adjustment (conditioning, restriction, or stratification) or standardization (inverse probability of exposure weighting) can be applied to enable conditional exchangeability between the exposure groups.

Finally, the positivity assumption requires that every individual in the study had, at the time of exposure, a non-zero probability of being exposed to either possible exposure level. In settings where individuals have contraindications or encounter prohibitive access barriers regarding at least one exposure level, this assumption would be violated.

Modern causal diagrams (i.e., directed acyclic graphs, or 'DAGs'), play an important role in designing and conducting Monte-Carlo studies, as they depict the subject-matter understanding and prior knowledge regarding the research question at hand, and potential threats to the structural assumptions defined above.[21] Depending on the pathways (arrows) that connect a specific variable (node) in a DAG with other variables, attributes are assigned that define a variable's relevance for facilitating (or hindering) valid causal inference (see Supplemental file 1 for details). If a DAG is carefully crafted using all available knowledge concerning the exposure, the outcome of interest, and all their mutually determining causes, it provides unambiguous structured guidance on the implementation of the data generation process within a simulation study.

In Figure 6.2, we present a DAG showing the presumed relationships between the exposure 'ACP' and the outcome 'potentially avoidable ED transfer from LTC' within the context of our planned observational study. The causal structure depicted in the DAG is informed by the findings of our recent systematic scoping review (see Supplemental file 2 for a detailed list of potential covariates identified).[29]

Figure 6.2 Directed acyclic graph for an observational study aiming at estimating the impact of advance care planning on the incidence of potentially avoidable emergency department transfers of long-term care home residents



*We used a practical approach to making somewhat less stringent assumption, i.e., knowledge is available for each covariance whether it is a cause of the exposure, and whether it is a cause of the outcome (VanderWeele, TJ. Principles of confounder selection. Eur J Epidemiol 2019;34(3):211-219)

6.5.4 Step 3 – Designing the simulation study

Once a DAG is created, a data-generating algorithm that mirrors its implied causal dependency structures can be set up. Under the assumption of specific statistical distributions for the variables encoded in the DAG, repeated sampling of data points is straightforward using generic statistical software.[36] Each generated dataset can then be used to exercise the respective analytical procedures planned to be employed for the actual study.

A simple but practically useful statistical distribution for generating simulated data is the Bernoulli distribution. The Bernoulli distribution generates binary variables and requires the specification of only one parameter: the prevalence or probability of an event $p \in (0;\ 1)$. Assume, for instance, the variable D describes the diseases status of an individual (i.e., $D = 0$ representing absence of the disease and $D = 1$ representing presence of the disease). The variable D can then be generated through sampling from a Bernoulli distribution with prevalence parameter p, where p is assumed to take a fix value between 0 and 1. We typically exclude the values p=0 and p=1 as both would imply no variation in the data, i.e., either everyone being disease free or everyone having the disease.

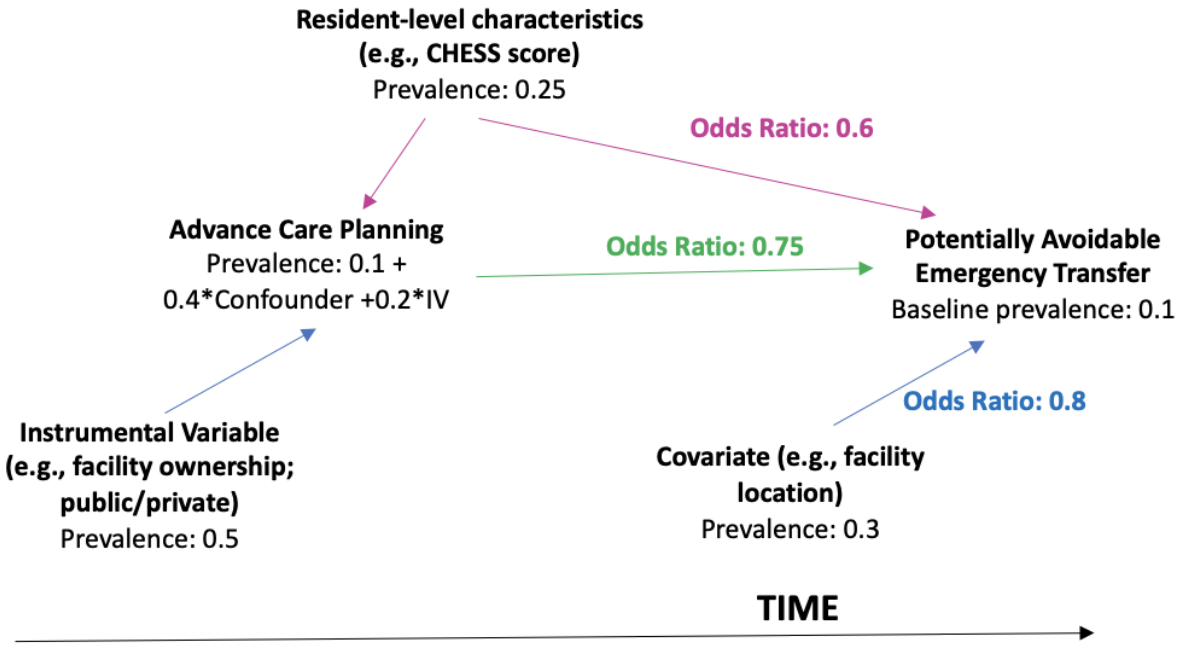
The value of p is typically informed using subject matter understanding, expert knowledge, evidence from the literature or may simply represent hypothetical values. In settings where p is uncertain or difficult to determine, simulation scenarios can be repeated for several plausible values of p. For example, one may run separate simulation studies emulating low prevalence scenarios such as $p \in \{0.01; 0.02; 0.03; 0.04; 0.05\}$. Note that the curly brackets "{…}" refer to a set of values whereas the brackets "(…)" refer to an open interval, implying any possible reel value within the interval boarders. The ability to emulate different possible realities though varying distribution parameters in a system of causally interrelated variables are one of the major appeals of simulation studies. In settings where variable distributions are rather discrete (such as count data) or continuous (such as measurement data), clinically relevant thresholds can be applied to inform data dichotomization, yielding intuitive binary variables for which informed choices for p can be made.

Finally, once prevalence values for key variables in the DAG are being defined, simple equations can be used to impose dependence structures that reflect specific magnitudes of effects on preferred effect measure scales. For instance, to generate a binary outcome Y that implies a risk difference of 0.3 between individuals who are having disease status $D = 1$ and disease status $D =$

0, the following linear equation can be applied: $p_Y = p_0 + 0.3 \cdot D$. With p_0 representing the risk for the event Y among individuals without disease. The variable Y is then generated from a Bernoulli distribution with parameter p_Y, which takes different values based on the value of D, i.e., presence or absence of disease. Similarly, if the effect measure of interest is the odds ratio (OR) or the relative risk, logit-linear or log-linear equations apply, respectively.

Figure 6.3 displays a simplified causal diagram along with all specified parameter values for our example observational study on transfers from LTC that selects one variable for exposure, outcome, confounder, and covariate for the purpose of illustration (we do not aim to conduct a mediation analyses although this may be of interest in some situations). Prevalences are set as being binary following respective Bernoulli distributions using the literature and/or substantive knowledge.

Figure 6.3 Pre-specified parameters of the simulation study for the observational study analysis



For example, in 2013–2014, 1 in 3 seniors living in Canadian LTC homes visited the ED (any ED transfer); and 1 in 3 of their ED visits was potentially avoidable.[33] This is reflected in

baseline outcome prevalence of 0.1 in the DAG. Baseline prevalence value is set to 0.1 for the exposure (ACP) using the knowledge of key LTC clinical informants. A potential confounder (i.e., resident having a Changes in Health, End-stage disease, Symptoms and Signs, or 'CHESS' score of 3 or 5, see details in Supplemental file 1) is set to 0.25.[37] 'Covariate' (i.e., facility location vis a vis distance to the ED) is set to 0.3.[38] In Canada, 54% of LTC homes are privately owned while 46% are publicly owned, which is reflected in instrumental variable.[39]

The literature on ACP interventions is not informative as to what might be a clinically meaningful reduction in potentially avoidable ED transfers.[29] One recent study reported lower rates of transfer to hospital or emergency of borderline significance (Incident Rate Ratio, 95% CI= 0.63 [0.39,1.01]), which became insignificant after adjusting for covariates and multiple comparisons.[40] Hence, the lower boundary of the exposure effect in the planned observational study is assumed to be OR=0.75 at the onset. That is, the ratio between the odds of success (i.e., outcome = 0) over failure (i.e., outcome = 1) if all subjects in the population have ACP and the odds of success if all subjects in the population did not have ACP. The effects of confounders and covariates are assigned an OR of 0.6 and 0.8, respectively, indicating relatively strong potential confounding and covariate effects when compared to the effect of the exposure.

As the effect measures of primary interest are ORs,[41] multivariable logistic regression analysis is a suitable statistical modeling approach to estimate and associated 95% confidence intervals (CIs) could be reported.[42,43]

6.5.5 Step 4 – Implementing the data simulation algorithm

Most statistical software packages enable random sampling from known statistical distributions such as the Bernoulli distribution. We are using the freely available statistical software R[36] to illustrate the data simulation for our observational study, pointing out that it is also possible to perform an equivalent data simulation using Microsoft Excel.[44]

The following simulation steps are to be taken in order to generate a dataset that matches the causal structure depicted by the DAG:

a) For each binary variable X in the DAG, generate its respective Bernoulli parameter p_X:
   - if no arrow points into X, the value of p_X is determined by external information.
   - if one or more arrows point into X, the value of p_X depends on a baseline

probability p_0 and the multiplicative (OR or risk ratio) or additive effect (risk difference) of all variables pointing into X.

For example: if variables V and W point into X, we can define p_X as:

$p_X = p_0 + \alpha \cdot V + \beta \cdot W$, with $0 < p_0 + \alpha + \beta < 1$ and $V, W \in \{0; 1\}$

Where α and β represent risk differences (with respect to X) between the levels of V and W, respectively.

b) Employing each generated parameter p_X, generate a series of n independent random samples from respective Bernoulli distributions. The parameter n is the sample size of the simulated observational study data.

c) Once all variables have been generated, the simulated data can be analysed with the pre-specified inference method(s) and the primary effect estimate of interest is being extracted and stored alongside its standard error and/or x% CI.
For example, if the inferential method of interest is a multivariable logistic regression, for each instance of simulated data, the estimated log OR of the outcome across exposure groups (and its standard error or x% CI) are being extracted. Where x% refers to a pre-specified level of statistical confidence (one minus Type I error).

d) The process of data generation, effect estimation, and extraction is then repeated many times. The exact number of simulations is determined by the simulation parameter N, which may take values between several hundred to tens of thousands of repetitions. Commonly reported number of simulations is N= 1000.[45] Monte Carlo Standard Error (estimates of standard deviation) might also be used in choosing N to verify the adequacy of data (was not shown here).[16] If data-generating parameters such as sample size or covariate adjustment sets are being changed, an additional set of N simulation runs must be performed for each new data setting, and the results stored accordingly for later processing and comparison.

In our simulated observational study, we set the number of simulations per simulation study to N=1,000 and repeated the data generating and result-extraction process for different sample sizes, $n \in \{1000, 2000, 4000\}$, and conditional effect parameters, $OR \in \{0.75, 0.70, 0.65\}$.

6.5.6 Step 5 – Evaluating the simulated data

The key results of a Monte Carlo simulation study (or multiple simulation studies with different parameter settings) are empirical distributions of effect estimates (and associated standard errors or CIs), under different hypothetical data scenarios and analytical approaches. These distributions are then used to assess the characteristics of the respective estimator (inference model) under different data settings. In Scenario 1, the average of all estimates obtained from a specific simulation study enables the assessment of estimation bias, through comparing this average to the underlying true (and known) exposure effect. Furthermore, the relative frequency of CIs excluding (or including) pre-defined clinically relevant effects can be used to assess the statistical power (or coverage rate), at a specific given sample size. The results of our simulations in the context of an observational study on potentially avoidable ED transfers from LTC indicate that a minimum 4,000 observations would provide 80% statistical power to reject the null hypothesis of no exposure effect if the truly underlying exposure effect would be equal to a conditional OR of 0.65 or higher (when applying a multivariable logistic regression model that adjusts for a measurable confounding variable at the resident level, such as the CHESS score).

In Scenario 2, changing the covariate adjustment sets and/or the strength of observed or unobserved confounding variables across different simulation studies can help gain understanding of the potential sensitivity (and robustness) of competing analysis strategies to misspecifications of the respective inference model(s). For example, if we consider the CHESS score variable, failure to adjust for this potential confounder would result in a 4.6% bias when estimating the exposure effect (estimated Exposure OR=0.62 instead of 0.65). Consequently, this would yield an artificially amplified statistical power of 21% (estimated statistical power increasing from 78% to 99%) (see Supplemental file 3). Depending on the study that is being designed, additional scenarios could be hypothesized by changing model parameters. For example, we may increase the baseline prevalence of exposure or outcome to verify its impact on statistical power. Another scenario could involve running the model twice, once with and once without a second potential confounder. If no change in results is observed, this may indicate that the variable in question may not be an actual confounder.

6.5.7 Step 6 – Disseminating the results

In this paper, we demonstrated the utility of Monte-Carlo data simulations to inform the design and analysis of a future observational study. Simulation results confirmed that our confounders are important to account for in our analysis and that increased in sample size would be required either by increasing the number of LTC homes or study period duration. We provided the DAG being used in a planned observational study in the LTC home context as well as the resources/description of processes that informed the DAG. In addition, we provide the steps (Figure 6.3) and the simulation codes (see Supplemental file 3) to allow the reader to replicate the simulation and adapt to other research questions in the LTC setting or in other clinical care settings.

6.6 Objective 3: What are the limitations of data simulations and how to mitigate them?

With the advancements of available computing power and statistical software, data simulations have become widely accessible in the broader health sector.[30] They are playing an increasing role in research studies that aim at informing public health interventions,[46] assessing complex system characteristics,[47] and decision-making in clinical practice.[17,48] The flexibility and advantages of data simulations, however, come with some limitations, mainly, oversimplification of scenarios and computational complexity.

6.6.1 Oversimplification of scenarios not reflecting real-life

As simulation scenarios are often simplified, they may not reflect the true complexity of the data encountered in real-life data analyses.[49] This means that the simulation should provide a not 'overly enthusiastic' scenario, because otherwise, we may be likely to have results that fit with the simulation designer's bias. Beyond increased computational power which makes it possible to examine many potential simulation scenarios with different combinations of distributional parameters and assumptions, there are two main ways to mitigate this issue: Plasmode datasets and the process of informing the DAG.

Plasmode simulation studies are a subclass of Monte Carlo simulations and used as a supplement to data simulations to get around the common concern of the realism and accuracy of exclusively computer-simulated data.[50] This approach gaining increasing attention among the pharmacoepidemiology milieu.[50] In pharmacoepidemiology studies, the complexities of large

administrative databases and dynamic exposure and outcome trajectories of individuals often requires sophisticated analytical strategies. Simulation approaches can help to test the effectiveness and robustness of specialized design and data-analytical approaches. The plasmode simulation framework retains the variable distributions and estimated correlation structures from complex observed data, and generates, as a function of the observed data, only specific aspects of the multivariate data distribution i.e., the exposure and outcome variable of primary interests (and their interdependence).[50] In simulation studies that employ observed data, the simulated data points are typically compared to the data in hand to ensure that the simulation strategy is producing realistic data.[51,52]

As we have demonstrated in this article via conducting a systematic scoping review,[29] knowledge syntheses can meaningfully inform the creation of causal diagrams that incorporate concrete real-world evidence. Working as a multidisciplinary team such as ours can optimize subject-matter knowledge in this process. In addition, a participatory research approach by involving stakeholders, who are affected by the issue under study, at the stages of both designing the study and interpretation of results can be beneficial.[53] In this study, we collaborated with the key LTC personnel by confirming clinical problems.[54] We also used our knowledge of a LTC setting (in the province of Quebec) in which we identified similar prevalence of potentially avoidable ED transfers to what was reported in the literature.[54] We therefore believe that our assumptions were realistic enough even though we used simple interrelations (not plasmode complexity). The latter was not possible in our case due to the lack of LTC administrative data in this province[55] where we plan to create a dataset via comprehensive resident chart reviews. Plasmode simulations, however, might be considered in other Canadian provinces or countries where electronic clinical datasets are available [e.g., LTC Resident Assessment Instrument (interRAI)[56] or Minimum Data Set (MDS) 3.0[57]].

6.6.2 Computationally complexity

The second limitation is that large simulation studies can be computationally expensive (i.e., requires a relatively large number of steps to complete) and time-consuming. The extent of this limitation depends on the number of scenarios/repetitions are considered, size of datasets, and complexity of statistical methods used.[49] To mitigate such challenges, first of all, we recommend that an expert in statistics oversees and reviews the simulation work. As well, one may keep the

scale of the simulation study modest and use a different effect measure when it deems more suitable.

The number of scenarios and repetitions can be moderated in a small-scale simulation study for the purpose of feasibility. In addition, binary variables are less complex than categorical or continuous variables in terms of their required assumptions and ability to serve modeling structures. However, this simplicity may come at the cost of information loss. Important continuous variables may therefore be approximated through an entire set of indicator variables (e.g., quantile-based or interval dichotomization), rather than a single binary variable.

These methods are also adaptable to different effect measures when appropriate. For example, if the subject-specific (or conditional) treatment effect is equal to the marginal (or population-average) treatment effect, then a measure of treatment effect is said to be collapsible, which is not true for OR measure.[42] In some contexts, therefore, relative risks (and risk differences) may provide greater information for clinical decision-making than relative measures of treatment effect as they are collapsible.[43]

6.7 Conclusions

Observational studies have tremendous value in research. This paper presents the straightforward means by which someone without in-depth statistical training or programing knowledge can set up a Monte-Carlo study to inform the design of an observational study. Data simulations can help illustrate the presence of potential bias by confounding in estimating exposure/treatment effects via exploring how bias and variation in sample size affect study inference. At the start of this process, researchers may have a range of questions pertaining the study design, data to be measured, and relevant analytical strategies. Through leveraging modern data simulation and causal inference frameworks, actionable clues can be obtained on how to design and not to design a study in various clinical care settings.

6.8 Acknowledgements

6.8.1 Conflict of interest

The authors declare no conflicts of interest.

6.8.2 Author contributions

This study stemmed from the course entitled "Readings in Family Medicine - FMED 602" taught by Dr. Tibor Schuster at McGill University in Winter 2019. Deniz Cetin-Sahin, as a PhD student in Family Medicine and Primary Care, led the study concept and design, performed data simulations using the class lectures as a source, conducted the literature review, and drafted the manuscript as part of her doctoral thesis project. Dr. Tibor Schuster, a biostatistician with years of experience and expertise in these methods, contributed to study concept and design, drafting and revision of the manuscript, and is the guarantor of the article. Dr. Machelle Wilchesky, an epidemiologist with expertise in dementia and LTC research, guided the clinical context of the simulation study and oversaw this work as the primary supervisor of the doctoral project. Drs. Robert W. Platt, Isabelle Vedel, and Greta G. Cummings contributed to drafting of the manuscript. All authors participated in critical revision of the manuscript for important intellectual content.

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6.8.4 Ethics approval

This study did not require ethics approval as it used a methodological approach.

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6.10 Supplemental Files

6.10.1 Supplemental file 1. Glossary of terms

Advance care planning (Exposure): Causal research questions often relate to *modifiable causes*. In this clinical epidemiology study, the exposure of interest is 'advance care planning (ACP)' under regular (non-experimental) conditions.

Why is the nature of our exposure important?:

- *Level of modifiability:* It may be possible to increase doing ACP in long-term care facilities by changing practices or certain interventions
- ACP is the starting point of the *causal chain* that may offer further opportunities of preventing negative outcomes of interest [*potentially avoidable emergency department transfer*]
- ACP again may impact the *plausibility and/or acceptance* of the causal claim: managing the resident in the facility instead of transfer to emergency department
- ACP determines the potential *policy change,* i.e., increase of the exposure, if the study is "successful"
- ACP determines the factors we need to measure to control for *confounding bias* as such factors must be *causally related* to the exposure. This is a particularly appealing advantage in settings where the exposure [ACP] is *under the control* of individuals (e.g., doctors, nurses, and other LTCF staff). *If we know exposure allocation preferences, we can control for all confounding factors.*

To meet the positivity and consistency assumptions ACP should be precisely defined. Advance Care Planning is a process of considering values and wishes and deciding on what kind of health (including advance directives for hospital transfers) and personal care residents would want in the future if they became unable to speak for themselves. It is an integral part of a Palliative Approach to Care, which focuses on meeting a person's and family's full range of needs — physical, psychosocial and spiritual — at all stages of frailty or chronic illness, not just at the end of life.[1] In long-term care facility settings, can be done for 1) Newly admitted residents; 2) All residents at regular intervals or if their health deteriorates; 3) Those experiencing advanced illness or nearing end of life. Our definition in this paper refers to having at least one documented ACP

meeting that has taken place between physicians and residents and/or their families/representatives (except for at the one that was done at the admission).

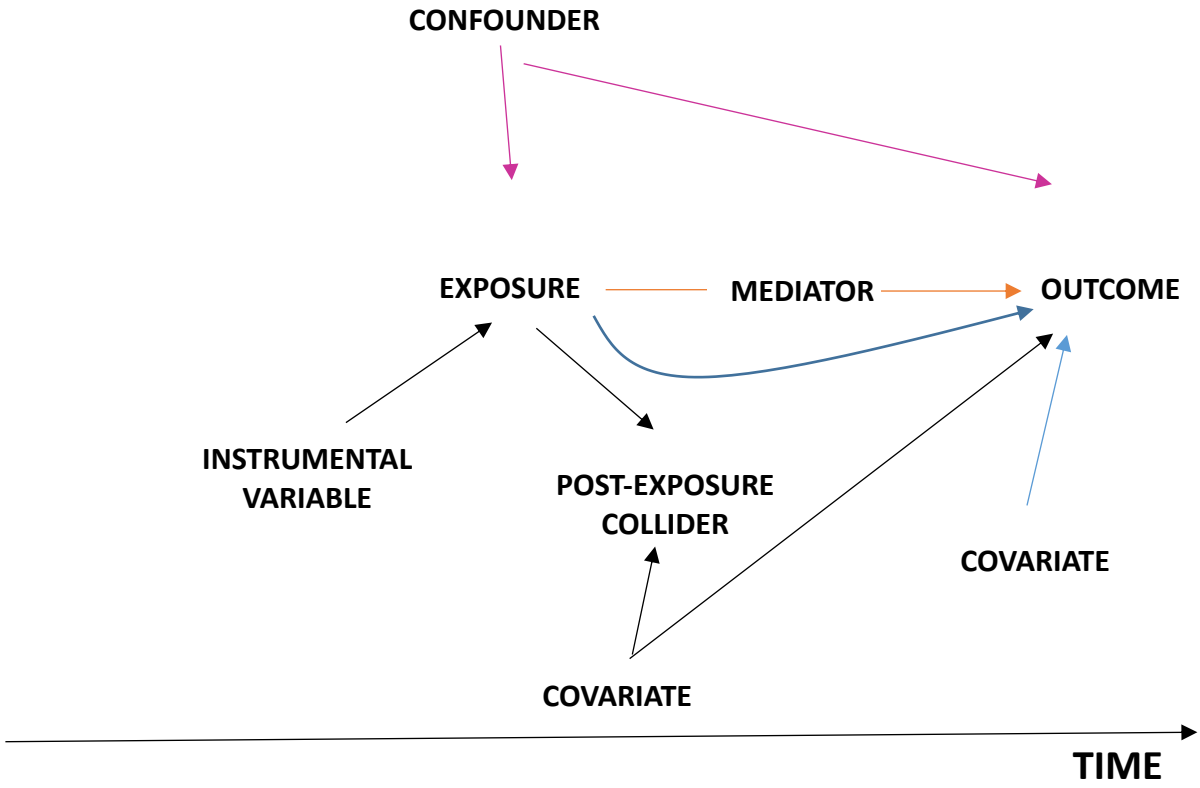
Potentially avoidable emergency department transfers (Outcome Variables): Causal research questions aim to answer what *effect* modifiable exposures may have on one specific outcome. The type of outcome determines the choice of *the statistical model* and the *effect measure*. In this study, the outcome of interest is potentially avoidable emergency department transfers.

We chose Canadian Institute for health Information's (CIHI) potentially avoidable emergency department transfers definition[2] for our analysis that includes both "*visits for selected potentially preventable conditions—similar to ambulatory care sensitive conditions and validated for long-term care facility residents—for which timely primary care management could have been effective*" ("CIHI Category 1"), and "*visits classified as less or non-urgent (low acuity)—according to the Canadian Emergency Department Triage and Acuity Scale*[3]*—and without inpatient admission*, *resulting in the patient returning directly to facility"* ("CIHI Category 2").[2] Category 1 transfers were identified using principal emergency department diagnoses, while Category 2 transfers were identified using the triage code and emergency department disposition for each transfer episode.[2]

Causal diagrams, namely Directed Acyclic Graphs (DAGs):

Depending on the pathways (arrows) that connect a specific variable (node) in a DAG with other variables, attributes are assigned that define a variable's relevance for facilitating (or hindering) valid causal inference. Depending on these attributes, the variable may be named 'confounder', 'instrument variable', 'collider' etc. (graphically shown and described below), each implying consequences on how the study design and/or the inferential analysis must take the variable in question into account.

Generic Directed Acyclic Graph for an observational study assessing the effect of a point-exposure on an outcome



Confounder: In epidemiology, for a factor to explain the difference between 'the measure of association' and 'the measure of effect that would be obtained with a counterfactual ideal' and thus confound, "the factor must affect or at least predict the risk or rate in the unexposed (reference) group, and not be affected by the exposure or the disease."[4] Vanderweele proposes a formal definition of a confounder as "a pre-exposure covariance C for which there exists a set of other covariates X such that effect of the exposure on the outcome is unconfounded conditional on (X, C) but such that for no proper subset of (X, C) is the effect of the exposure on the outcome unconfounded given the subset".[5] In this data simulation study, we adapted VanderWeele's practical approach to making somewhat less stringent assumption, i.e., knowledge is available for each covariance whether it is a cause of the exposure, and whether it is a cause of the outcome.[6] The following rules were therefore applied to covariance control decisions: 1) control for each covariance that is a cause of the exposure, or of the outcome, or of both; 2) exclude from this set any variable known to be an instrumental variable; and 3) include as a covariance any proxy for an unmeasured variable that is a common cause of both the exposure and the outcome.[6]

Instrumental variable: When it is known that there are important confounders that cannot be measured, there will be residual bias in causal estimates. In this case, there are other methods that can validly estimate causal effects under an alternative set of assumptions that do not require measuring all adjustment factors. Instrumental variable estimation is one such method.[7] A variable can be 'an instrument' when it meets three instrumental conditions: 1) It is associated with exposure, 2) it does not affect outcome except through its potential effect on exposure, and 3) It does not share any causes with the outcome (i.e., it cannot be influenced by other unmeasured predictors of the outcome).[7] Three commonly used categories of candidate instruments are genetic factors,[8] physician's (or a care provider's) preference for one treatment over the other,[9] and 3) access to the treatment.

Mediator: Mediator variables are those that lie on the causal pathway between exposure and outcome, and are important for the differentiation between direct and indirect effects.[10] Indirect exposure effects involve changes of an outcome through changes in mediator levels caused by changes in the exposure status. Decomposing the total causal effect of an intervention into direct and indirect or 'mediated' causal effects may be of an interest in scenarios where it may be more feasible or cost-effective to intervene at the level of the mediator rather than the exposure in order

to affect the outcome.[10] The exchangeability condition may be violated when adjusting for certain variables such as mediators.[11]

Collider: These variables have two or more direct 'ancestors' (i.e., two variables that causally predict the collider variable).[11] Problems arise if collider variables that follow exposure are adjusted for in the analysis (e.g., conditioning on a collider). Conditioning on the common effect conveys an association between two otherwise independent variables, which introduces selection bias.[12]

Covariates: Covariates are variables that *causally affect* the outcome. If a covariate also affects the level of exposure, it constitutes a confounding variable. If a covariate solely predicts the outcome, i.e., is independent of the exposure, there is no confounding bias. However, even if there is true independence between a covariate and the exposure, sampling error can still lead to imbalances of this covariate in the study population. For this reason, adjustment for (or conditioning on) covariates is recommended as it will help to increase precision and minimize estimation error in a single study.

CHESS score: Changes in Health, End-stage disease, Symptoms and Signs (CHESS) scale provides a useful test to predict mortality and to measure instability in health as a clinical outcome[13] based on the Resident Assessment Instrument Minimum Data Set (RAI-MDS 3.0).[14] The scale includes 11 items and gives a score between 0 (most stable) and 5 (least stable).[15] Having a CHESS score of 3 or 4 was found associated with greater risk of 30-day hospitalization than a score of 0 or a score of 5.[15] Since the Province of Quebec is not involved with the MDS system,[14] 11 CHESS items within the interRAI Long-Term Care Facilities Assessment Form and User's Manual, 9.1. 2009[16] was operationalized from various sections of the charts for the observational study.

References for Supplemental file 1:

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11. Shrier I, Platt RW. Reducing bias through directed acyclic graphs. *BMC Med Res Methodol* 2008; 8(1): 70.
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6.10.2 Supplemental file 2. Covariates included in the directed acyclic graph

Informed by a systematic scoping review (variables randomized, adjusted, stratified, or matched in the studies included)

R: Resident/Family Covariates
F: Facility/ Resources Covariates
P: Practice/Process Covariates
O: Other Covariates

	Main covariate	May include	Example of measures for the covariate
R	**Age**	Age variable	Baseline ≥ 65 (inclusion criteria), Age at the time of transfer ≥ 80, Categorical age groups with 5-year increments
R	**Sex**	Sex or gender	Female, male
R	**Sociodemographic Variables**	Race/ethnicity	White vs non-white, % African American residents
		Marital status	Married, widow, single
		Primary Language	English as first language; Preferred language
		Primary insurance	Private insurance; Original reason for entitlement to Medicare (elderly/disabled); Duration of dual eligibility indicator of frailty; Dual-eligible status indicating beneficiaries qualifying for both Medicare and Medicaid (Government-funded residential aged care)
R	**Status Prior to LTC home admission**	Health status prior admission to LTC home	Health conditions recorded in the 2 years prior to admission to LTC home that were considered predictive of hospital readmission (metastatic cancer with solid tumor, other malignant cancer, chronic pulmonary disease, congestive heart failure, dementia, diabetes with chronic complications, hemiplegia or paraplegia, moderate or severe liver disease, other liver disease, peripheral vascular disease, renal disease)
		Frailty 2 year before admission	Number of conditions linked to frailty recorded in 2 years prior to admission to LTC home: Anxiety or depression, cognitive impairment, functional dependence, fall or significant fracture, incontinence, mobility problems and pressure ulcers
		Hospital use before admission to LTC home	Unplanned, potentially avoidable, elective ED transfers and hospitalizations, hospital bed days, outpatient visits
R	**Time since admission to LTC home**	Length of stay in LTC home	Newly admitted (i.e., <100 days, stay at least certain days (5-42 days)) Long-term stay (i.e.,>100 days, ≥90 days)
		Number of days between baseline and death	If residents who deceased in LTC home are identified retrospectively
R	**Comorbidity***	Number of comorbidities	Charlson comorbidity index; Hierarchical Condition Category score; Multimorbidity: ⩾2 diseases or chronic disorders; Elixhauser comorbidity scores calculated based on primary and secondary ICD-10 diagnoses codes
		Co-existing diseases	Apoplexia, chronic obstructive pulmonary disease, angina pectoris, heart failure, diabetes, cancer, dementia/Parkinson's disease, cancer, cardiovascular disease, frailty, organ failure, other
R	**Medications***	Number of medications	≥ 5 medications

	Main covariate	May include	Example of measures for the covariate
		Polypharmacy	Residents using 20 or more prescription drugs
R	**Functional status***	Activities of daily living dependencies	CADET Score: Scores can range from 5 (self-care independence) to 11 to 15 (need for total assistance); Barthel Index; Functional Assessment Staging Tool (FAST Scale); Morris activities of daily living score; Personal self-maintenance score
R	**Mental Status***	Depression	Psychogeriatric Assessment Scale; Level of depression
		Other psychiatric disease	Mental Status Score; Morale Score
R	**Dementia/ Cognitive Deficiency***	Level of cognitive impairment	Incompetence, Decisional capacity: Patient Activation Measure (PAM-13); MMSE score; FROMAJE Score ranging from 7 to 8 (no abnormality) to 13 or greater (severe depression or dementia); Psychogeriatric Assessment Scale
		Dementia	Diagnosis of Alzheimer's disease or related dementia; Dementia stage: global deterioration scale
R	**Frailty†**	Frailty Scale scores	Clinical Frailty Scale used to determine frailty of all participants at baseline (severely frail, very-severely frail, terminally ill)
R	**Mortality risk**	Life expectancy	Mortality Risk Score (MRS3) score; Mortality Prediction Score; A validated mortality risk score based on demographic, clinical, and functional characteristics
R	**Quality of Life**	Generic quality of life scores	SF-12 physical component score; SF-12 mental component score; Quality of life in Late-Stage Dementia
R	**Care Level Need**	Degree of care need	E.g., hospice care
R	**Advance Directive Choices**	Advance care plan choices	Presence or absence of "Do not resuscitate" or "Do not hospitalize" order; Comfort Care Directive
		Living will	Medical enduring Power of Attorney
R	**Prior Acute Care Use**	Previous readmissions	Number of readmissions in the past 6 months
R	**Clinical Status Prior to Transfer***	Vital signs	Blood Pressure, Pulse, Temperature, Respiratory Rate, Oxygen saturation
		Lab values	C-Reactive Protein value
		Nutritional status	Reduced food intake, Body mass index, Oral feeding tube, Parenteral/IV nutrition, Nutritional supplement
		Hydration	Dehydration, Reduced fluid intake
		Clinical scores	Septicemia score; A Minimum Data Set variable denoting unstable, deteriorating, or declining cognitive or functional status; Resident Assessment Form subscore as a proxy for poor function; % independent on Minimum Data Set measures (Cognitive status, Bed mobility)
		Respiration	Having non-invasive ventilation support
		Skin condition	Pressure ulcers
		Urination	Bladder and bowel incontinence
		Function	Bedbound
		Pain	Pain Index Scale
		Mental Status	Not alert/not oriented; Presence of any symptom of delirium
R	**Resident/family satisfaction**	Satisfaction with care	Satisfaction of nursing home staff and patients with the use of the care protocol; Family satisfaction with the quality of health care provided to residents

	Main covariate	May include	Example of measures for the covariate
R	**Resident/family values/beliefs**	Religion, personal values	Beliefs concerning preservation of life at any cost
F	**Facility Type**	Facility size	Number of beds
		Ownership/ profit status	Public, For-profit status, non-profit status
		Chain affiliation	Single privately owned; Part of multichain, corporate chain; Co-located with public hospital
		Bed type, case-mix	Level of care (high, low, mix); Combined rest-home and hospital/rest-home, dementia, private; Care home registered as caring for older people only; (Beds per unit (long-term, short-term, dementia), % long-stay residents, Facility average case-mix, Ratio of high care to low care beds)
		Special need groups	Proportion of residents with dementia; % with severe cognitive impairment; Average activities of daily living score; % with nursing therapies (Skin care, Bowel training, Bladder training, Range of motion, Restorative nursing, Restraints)
F	**Facility Staffing patterns**	Staffing	Medical director hours per week; Number of physicians; After-hours Primary Care Physician cover; % of physicians who signed over their off-hours coverage to the telemedicine service; Number of Nurse Practitioners or Physician Assistants; Ratio of RN/RN + LPN
		Turnover	Administrator, Nursing Director, and Medical Director changes past 3 years; Nurse turnover (RN, LPN, Certified NA); % Annual nursing staff turnover
		Caseload	Nursing staff hours to bed ratio; Number of certified nursing assistant, LPN, and RN hours per resident day; Licensed Staff Hours per resident per day; Total RN hours/day/resident; Total NA hours/day/resident; Number of nursing assistant full-time equivalents per 100 beds; Number of nurse full-time equivalents per 100 beds; Number of coordinating physician full-time equivalents per 100 beds
F	**Facility Diagnostic, Treatment, and Specialty Resources**	Services available	Presence of on-site point-of-care testing; Intravenous fluids, Intravenous antibiotics; Intravenous other drug, Laboratory turnaround <4 hours, Xray turnaround <4 hours, Medication turnaround <4 hours; Having noninvasive ventilation support
		Electronic Health Record	Availability of electronic health records in LTC home
		Dementia Unit	Presence of dementia-specific beds and special units
F	**Unobserved facility characteristics**	All time-invariant characteristics	LTC home culture (i.e., prevailing attitudes about patient-centered care, quality improvement, and providing a home-like environment)
F	**Facility Location**	Geographical location	Proximity to the hospital; Urban, outer metropolitan/rural; Regions (East, West); States, county
		Geographic LTC home Market characteristics	Herfindahl index for LTC home beds in county: A county-level (0 to 1.0 [no competition]) derived from The Online Survey Certification and Reporting (OSCAR) LTC home bed data included to control for the competitiveness of the LTC home's market

	Main covariate	May include	Example of measures for the covariate
			increasing numbers of LTC home beds within the catchment area over the time period
		Location's socioeconomic status	Index of Multiple Deprivation quintile
F	**Prior Facility Rates**	Previous facility acute care use	Death in hospital; Average Acuity Index of the facility; Probability of a resident being hospitalization-free from time of eligibility Annual emergency attendances, admission; Re-hospitalization rates of key diagnoses of acute myocardial infarction, congestive heart failure, and pneumonia
		Mortality rates	Total deaths in previous 12 months
		Occupancy rate	Bed turnover rate change in admission rate
			% Beds occupancy
		Quality performance	Nursing Home Compare Star Rating
P	**Intervention Fidelity**	*When applicable*	Extent of engagement of nursing homes; Differences between homes in 5 care process measures (team cohesion; communication/coordination; perceived team performance; perceived palliative care competency; and organizational readiness for palliative care); Completion of different Situation-Background-Assessment-Recommendation (SBAR) sections
P	**Duration of intervention**	*When applicable*	Offset of follow-up days
P	**Usual care**	Practices in place	Models of care other than intervention; Physician order form; Medical Orders for Scope of Treatment (MOST); Form in use; Staff knowledge and skills
O	**Health care system**	Program, Policies	Dual-eligible individuals (Prepaid Medical Assistance program and Medicare or Minnesota Senior Health Options)
O	**Season**	Seasonal effect	Calendar month
O	**Year**	Year effect	Year of resident's death; Cohort year
O	**Transfer Characteristics**	Triage category and time	Triage Scale score
		Mode of arrival to ED	Arriving by ambulance
		Day and time of ED arrival	Weekday/ weekend admission; Working hours/after hours
		Disposition from ED	Whether the individual was discharged or admitted to hospital
		Reasons	Reasons for acute care presentation/ admission; The most common reasons for presentation by Major Diagnostic Category

ED: Emergency Department; LPN: Licensed Practical Nurse; RN: Registered Nurse; LTC: Long-Term Care

*Variable that contributes to frailty

†Selected 50 Items of Frailty Index for long-term care home residents are provided in the following page

Selected 50 Items of Frailty Index for long-term care home residents

#	Items	Rockwood, 2007	Fougère, 2016	Clegg eFI, 2016	Seitz, 2011	Wilchesky, 2021
1	Anemia and haematinic deficiency			X		
2	Aspiration pneumonia				X	
3	Arrhythmia (or pacemaker/defibrillator)	X				
4	Syncope or blackouts	X				
5	Cerebrovascular problems	X				
6	Congestive heart failure	X				
7	Coronary heart disease		X			
8	Myocardial infraction	X				
9	Heart valve disease			X		
10	Hypertension	X				
11	Chronic respiratory disease	X				
12	Diabetes		X			
13	Liver disease		X			
14	Malignant disease	X				
15	Falls	X				
16	Hip fracture				X	
17	Kidney disease		X			
18	Urinary system disease			X		
19	Thyroid disease	X				
20	Osteoarthritis		X			
21	Osteoporosis		X			
22	Pain		X			
23	Tremor	X				
24	Parkinson's disease	X				
25	Peptic ulcer disease			X (peptic ulcer)		
26	Peripheric vasculary disease			X		
27	Skin problems	X				
28	Decreased Visual Acuity		X			
29	Hearing Loss		X			
30	Disability in self-feeding		X			
31	Problems with bathing	X				
32	Problems getting dressed	X				
33	Problems carrying out personal grooming	X				
34	Urinary incontinence	X				
35	Bowel incontinence					X
36	Toileting problems	X				
37	Disability in transferring		X			
38	Impaired mobility	X				
39	Dementia					
40	Memory and cognitive problems	X				
41	Changes in general mental functioning	X				
42	Depression/dysphoria	X				
43	Diagnosis of delirium	X				
44	Anxiety			X		
45	Agitation/aggression (chronic)			X		
46	Other neuropsychiatric symptoms*		X			
47	Sleep disturbances	X				
48	Involuntary weight loss/*anorexia*		X			
49	Indwelling bladder catheter					X
50	Polypharmacy: ≥9 medications			X		

*Presence of any of the following: Sleep and nighttime behavior changes, delusions, hallucinations, euphoria, apathy, disinhibition, irritability or lability, aberrant motor behavior, appetite/eating changes

Frailty is defined by Rockwood et al. as "a multidimensional syndrome of loss of reserves (energy, physical ability, cognition, health) that gives rise to vulnerability".[1] The Frailty Index is a measure by which the risk of adverse health outcomes can be calculated. It enumerates a checklist of deficits relating to medical conditions, physical functioning and well-being, and as such is regarded as being an objective marker of deficits accumulation.[2,3] We will compute the Frailty Index by including 50 items (Additional file 2) pertaining to the presence and/or severity of current diseases, functional autonomy (activities of daily living), cognition, history of falls, evidence of anorexia, and physical and neurological signs from the clinical examinations. These items were developed based on the original Frailty Index[2] Rockwood et al(the one that was used in the INCUR study[3]). Additional items that were applicable to long-term care home context were adapted from Clegg's electronic Frailty Index,[4] the study of Seitz et al.,[5] and the trial of Wilchesky et al[6] considering the feasibility of collecting these items form resident charts. Each deficit will be dichotomized (present/absent) to represent frequency of the problem. A person with 5 deficits, for example, would have an index score of 5/50 = 0.10. In the data simulation study, we followed established cut points as the most frail having the Frailty Index ≥ 0.45.[7]

References for Supplemental file 2:

1. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. *CMAJ* 2005; 173(5): 489-95.
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6.10.3 Supplemental file 3. Step-by-step R codes

Monte Carlo data simulations tutorial: A method to inform the design and analysis of observational studies illustrated using an example from the long-term care setting

Supplemental file 6.10.3 Step by step R codes

Step 0. Describing applied context: study design, research question(s) and target population

For illustration, the example of designing an observational study in the context of the long-term care (LTC) setting to measure impact of an exposure of interest (advance care planning -ACP) on the primary study outcome (potentially avoidable emergency department transfers) is used. Our aim is to inform an observational study protocol to estimate the impact of documented advance cafe planning updates (a real-world exposure existing under regular condition, i.e., non-experimental) on the incidence of potentially avoidable ED transfers (outcome of interest) among LTC residents.

Step 1. Defining specific study characteristics that are to be assessed using data simulation

Bias magnitudes when estimating exposure (ACP) effects using ordinary inference methods that do not account for potential confounding bias.
Estimation of the statistical power and minimum sample size needed to detect clinically relevant effect sizes when applying confounder-adjusted inference approaches.

Step 2. Informing a structural (data generating) model via knowledge synthesis

We use robust external knowledge to verify structural assumptions regarding consistency, (conditional) exchangeability, and positivity. We display a causal diagram (Directed Acyclic Graph) showing the presumed relationships between the exposure and the outcome of interest within the context of the observational study.

Step 3. Designing the simulation study

We set up a data-generating algorithm that mirrors its implied causal dependency structures. Under the assumption of specific statistical distributions for the variables encoded in the causal diagram, we repeat simulation scenarios for several plausible values of p (typically informed using subject matter understanding, expert knowledge, evidence from the literature or may simply represent hypothetical values).

Step 4. Implementing the data simulation algorithm

We generate a dataset that matches the causal structure depicted by the Directed Acyclic Graph.

```
set.seed(12345)
N<-1000000 # specify sample size (corresponds to nodes in the text)
pIV<-0.5 # prevalence of the Instrumental Variable (IV). 54% of LTC homes in Canada are privately own
ed and 46% are publicly owned (CIHI)
IV<-rbinom(N,1,pIV) # sampling IV
pConfounder<-0.25 # prevalence of confounding variable
Confounder<-rbinom(N,1,pConfounder) # sampling Confounder
```

```
pExposure<-0.1+0.4*Confounder+0.2*IV
Exposure<-rbinom(N,1,pExposure) #sampling Exposure
```

According to the causal diagram, the prevalence of Exposure must depend on the Confounder and the IV. pExposure=0.1 if Confounder=0 & IV=0; pExposure=0.50 if Confounder=1 & IV=0; pExposure=0.70 if Confounder=1 & IV=1

```
pCovariate<-0.3 #prevalence of Covariate
Covariate<-rbinom(N,1,pCovariate) # sampling Covariate
```

Linear predictor of the outcome (needed because effect will be on the odds ratio scale)

```
lpOutcome<-log(0.10/0.90)+log(0.6)*Confounder+log(0.75)*Exposure+log(0.8)*Covariate
pOutcome<-plogis(lpOutcome) # converting linear predictor into probability vector
Outcome<-rbinom(N,1,pOutcome)
```

Combine the simulated variables to a dataset.

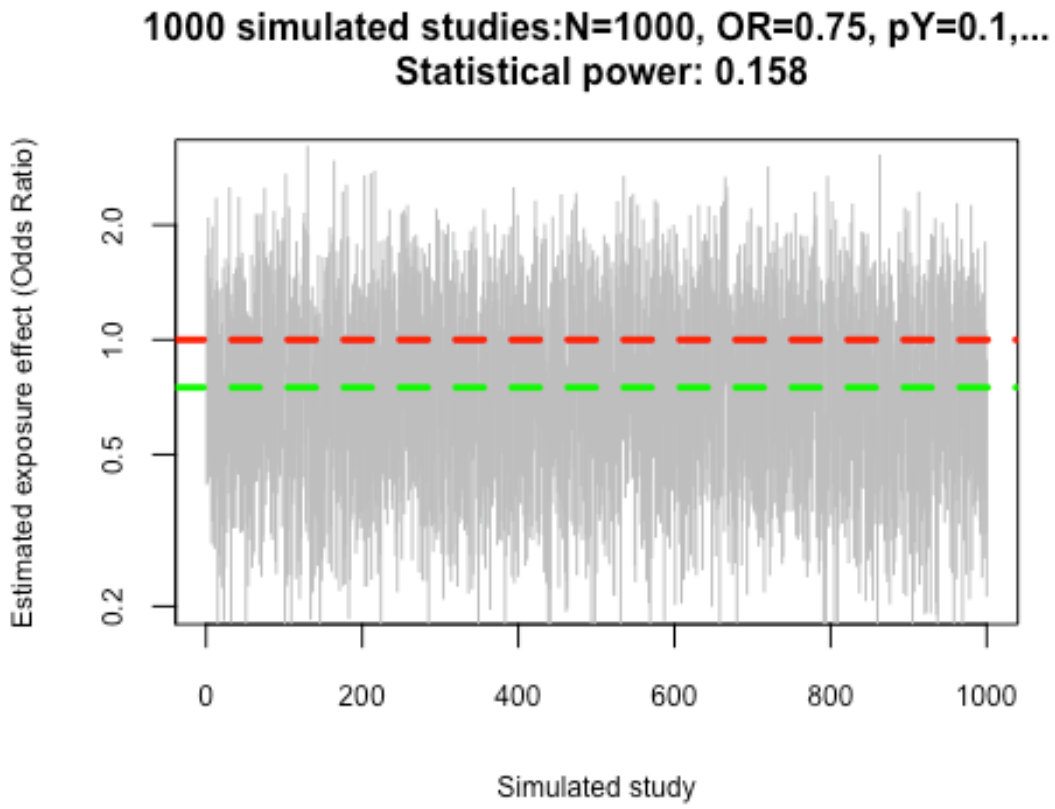
```
simdata<-data.frame(IV,Exposure,Confounder,Covariate,Outcome)
# fit a binary logistic regression model
fitlogisticmodel<-glm(Outcome~IV+Exposure+Confounder+Covariate,data=simdata, family="binomial")
# Obtain summary fit statistics of the model. Note that the estimated coefficients are log Odds Ratios
summary(fitlogisticmodel)

##
## Call:
## glm(formula = Outcome ~ IV + Exposure + Confounder + Covariate,
##     family = "binomial", data = simdata)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.4613  -0.4602  -0.4132  -0.3237   2.5608
##
## Coefficients:
##              Estimate Std. Error  z value Pr(>|z|)
## (Intercept) -2.191800   0.005892 -371.990   <2e-16 ***
## IV           0.004767   0.007579    0.629    0.529
## Exposure    -0.313106   0.009649  -32.449   <2e-16 ***
## Confounder  -0.509732   0.010627  -47.964   <2e-16 ***
## Covariate   -0.225939   0.008395  -26.913   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 559057  on 999999  degrees of freedom
## Residual deviance: 552688  on 999995  degrees of freedom
## AIC: 552698
##
## Number of Fisher Scoring iterations: 5
```

```
# Obtain ORs from the estimated log ORs and compute 95% confidence intervals for the estimated ORs.
ORs<-exp(fitlogisticmodel$coef)
cbind(ORs,exp(confint(fitlogisticmodel)))

## Waiting for profiling to be done...

##                 ORs     2.5 %    97.5 %
## (Intercept) 0.1117155 0.1104312 0.1130115
## IV          1.0047781 0.9899626 1.0198132
## Exposure    0.7311724 0.7174582 0.7451163
## Confounder  0.6006563 0.5882529 0.6132777
## Covariate   0.7977665 0.7847326 0.8109868

simdat<-function(N=1000,OR=0.75,pY=0.1) #N="nsim", these are default values, if we don't put them,
R will ask
{
 pIV<-0.5
 IV<-rbinom(N,1,pIV) # sampling IV
 pConfounder<-0.25 # prevalence of confounding variable
 Confounder<-rbinom(N,1,pConfounder) # sampling Confounder
 pExposure<-0.1+0.4*Confounder+0.2*IV
 Exposure<-rbinom(N,1,pExposure) # sampling Confounder
 pCovariate<-0.3 #prevalence of Covariate
 Covariate<-rbinom(N,1,pCovariate) # sampling Covariate
# Linear predictor of the outcome (needed because effect will be on the odds ratio scale)
 lpOutcome<-log(pY/(1-pY))+log(0.6)*Confounder+log(OR)*Exposure+log(0.8)*Covariate #now it is a
general formula
 pOutcome<-plogis(lpOutcome) # converting linear predictor into probability vector
 Outcome<-rbinom(N,1,pOutcome)
# Combine the simulated variables to a dataset
 simdata<-data.frame(IV,Exposure,Confounder,Covariate,Outcome)
 return(simdata)
}
```

Now it is easy to generate a dataset that follows our simplified causal structure. The next step is to write a for-loop that generates 1000 datasets at a given sample size (say N=1000) and pre-specified effect (say OR=0.75), stores the result (CI of the estimated exposure effect and p-value) for each iteration of the loop.

```
p.values<-rep(NA,1000)
ORs<-rep(NA,1000)
CIs<-matrix(NA,1000,2)
set.seed(123)
for (i in 1:1000)
{
 fitlogisticmodel<-glm(Outcome~IV+Exposure+Confounder+Covariate,data=simdat(N=1000,OR=0.75),
family="binomial") # run logistic model
 p.values[i]<-summary(fitlogisticmodel)$coef[3,4] # extract p-value
 ORs[i]<-exp(fitlogisticmodel$coef[3]) #extract estimated OR
 CIs[i,]<-exp(suppressMessages(confint(fitlogisticmodel)[3,])) # extract CI for OR
}
```

```
plot(c(1,1000),c(0.2,3),type="n",log="y",xlab="Simulated study",ylab="Estimated exposure effect (Odds Ratio)",
    main=paste("1000 simulated studies:N=1000, OR=0.75, pY=0.1,...\n Statistical power:",mean(p.values <0.05)), cex.main=1, cex.lab=0.75, cex.axis=0.75)
segments(1:1000,CIs[,1],1:1000,CIs[,2],col="grey")
abline(h=0.75,lty=2,col="green",lwd=3)
abline(h=1,lty=2,col="red",lwd=3)
```



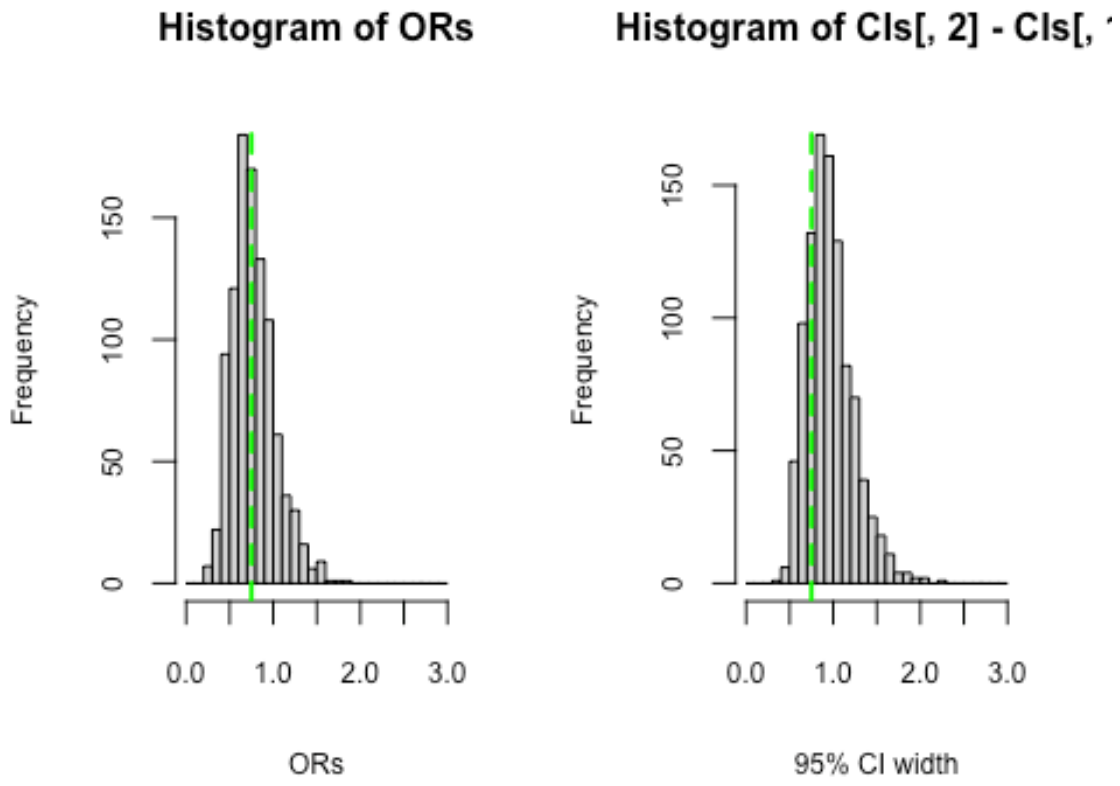
Step 5. Evaluating the simulated data

We check empirical distributions of effect estimates (log ORs) (and associated standard errors or confidence intervals), under different hypothetical data scenarios. We make specific alterations of parameter values to investigate how outcomes, parameter estimates, and model properties change. To do so, we created a range of scenarios by varying parameter values (effect size, sample size, confounders) and visualized the resulting differences in key data and model performance characteristics graphically.

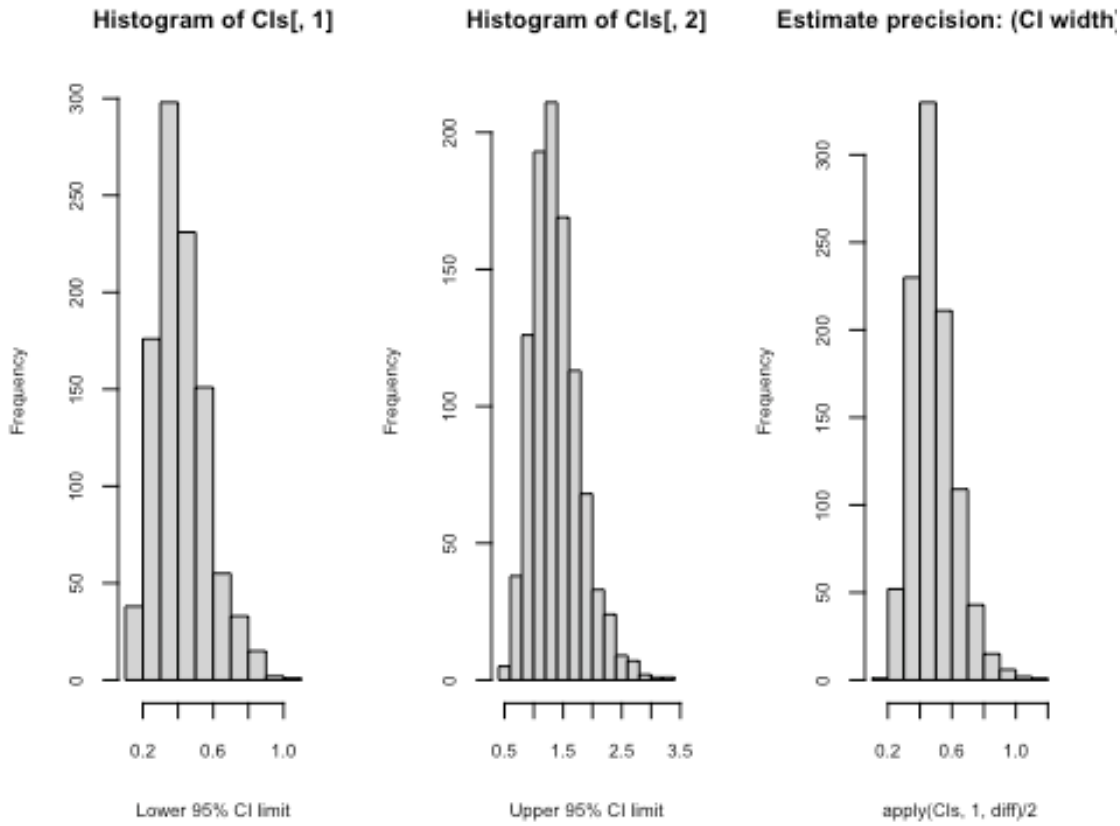
Scenario 1: Initial scenario The average of all estimates obtained from a specific simulation study enables the assessment of estimation bias, through comparing this average to the underlying true (and known) exposure effect. Furthermore, the relative frequency of confidence intervals excluding (or including) pre-defined clinically relevant effects can be used to assess the statistical power (or coverage rate), at a specific given sample size

Note that power is calculated estimating the proportion of p.values that is less than 0.05 (i.e. assuming a two-sided 5% level of significance). We check the histogram of ORs and CIs. It should be unbiased, so this is fine:

```
par(mfrow=c(1,2))
hist(ORs,breaks=seq(0,3,by=0.1), cex.main=1, cex.lab=0.75, cex.axis=0.75)
abline(v=0.75,lty=2,col="green",lwd=2)

hist(CIs[,2]-CIs[,1],breaks=seq(0,3,by=0.1), xlab="95% CI width", cex.main=1, cex.lab=0.75, cex.axis=0
.75)
abline(v=0.75,lty=2,col="green",lwd=2)
```




```
par(mfrow=c(1,3))
hist(CIs[,1],xlab="Lower 95% CI limit", cex.main=1, cex.lab=0.75, cex.axis=0.75)
hist(CIs[,2],xlab="Upper 95% CI limit",cex.main=1, cex.lab=0.75, cex.axis=0.75)
hist(apply(CIs,1,diff)/2,main="Estimate precision: (CI width)/2",cex.main=1, cex.lab=0.75, cex.axis=0.75
)
```

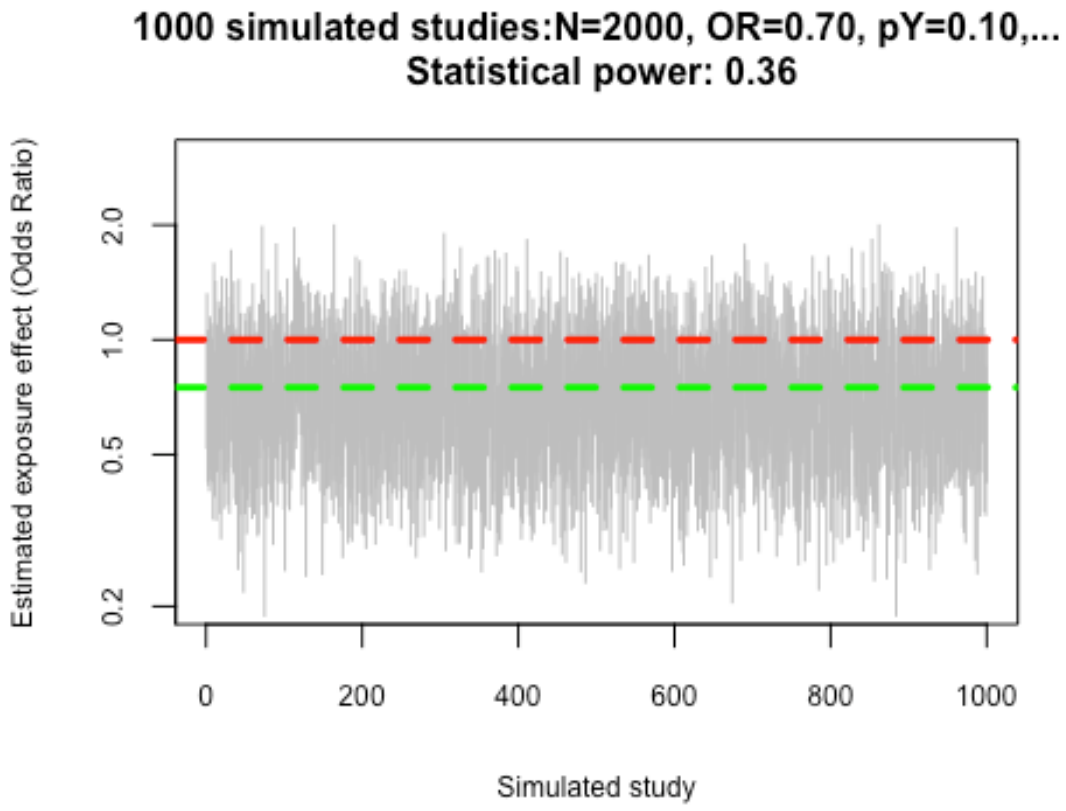



```
#Monte Carlo Standard Error (estimates of standard deviation) is suggested in choosing nsim to verify th
e adequacy of data. install.packages("mcmcse")
```

We can see the worst case scenarios. When we change the sample size we also check the precision (CI). We may need to increase sample size because if the true OR is 0.75, we don't want to get it to be upper side of the lower CI. In noninferiority studies, OR= 0.8 would be enough to observe.

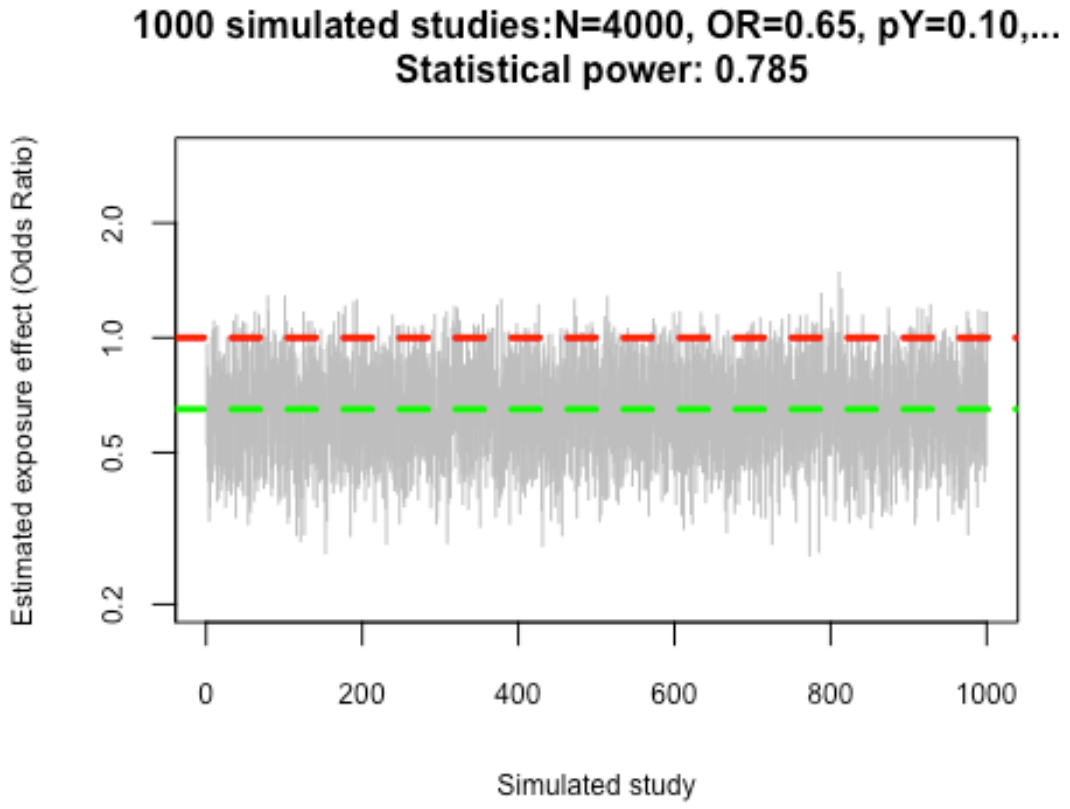
```
gimmePower<-function(N=2000,OR=0.70,pY=0.10,nsim=1000)
{
 p.values<-rep(NA,nsim)
 ORs<-rep(NA,nsim)
 CIs<-matrix(NA,nsim,2)
 set.seed(123)
 for (i in 1:nsim)
 {
  fitlogisticmodel<-glm(Outcome~IV+Exposure+Confounder+Covariate,data=simdat(N,OR), family="b
inomial") # run logistic model
  p.values[i]<-summary(fitlogisticmodel)$coef[3,4] # extract p-value
  ORs[i]<-exp(fitlogisticmodel$coef[3]) #extract estimated OR
  CIs[i,]<-exp(suppressMessages(confint(fitlogisticmodel)[3,])) # extract CI for OR
 }
 plot(c(1,nsim),c(0.2,3),type="n",log="y",xlab="Simulated study",ylab="Estimated exposure effect (Odd
s Ratio)",main=paste("1000 simulated studies:N=2000, OR=0.70, pY=0.10,...\n Statistical power:",mean(
```

```
p.values<0.05)),cex.main=1, cex.lab=0.75, cex.axis=0.75)
  # note that power is calculated estimating the proportion
  # of p.values that is less than 0.05 (i.e. assuming a two-sided 5% level of significance)
  segments(1:nsim,CIs[,1],1:nsim,CIs[,2],col="grey")
  abline(h=0.75,lty=2,col="green",lwd=3)
  abline(h=1,lty=2,col="red",lwd=3)
}
gimmePower(N=2000,OR=0.70,pY=0.10,nsim=1000)
```




```
gimmePower<-function(N=4000,OR=0.65,pY=0.10,nsim=1000)
{
  p.values<-rep(NA,nsim)
  ORs<-rep(NA,nsim)
  CIs<-matrix(NA,nsim,2)
  set.seed(123)
  for (i in 1:nsim)
  {
    fitlogisticmodel<-glm(Outcome~IV+Exposure+Confounder+Covariate,data=simdat(N,OR), family="b
inomial") # run logistic model
    p.values[i]<-summary(fitlogisticmodel)$coef[3,4] # extract p-value
    ORs[i]<-exp(fitlogisticmodel$coef[3]) #extract estimated OR
    CIs[i,]<-exp(suppressMessages(confint(fitlogisticmodel)[3,])) # extract CI for OR
  }
  plot(c(1,nsim),c(0.2,3),type="n",log="y",xlab="Simulated study",ylab="Estimated exposure effect (Odd
```

```
s Ratio)",main=paste("1000 simulated studies:N=4000, OR=0.65, pY=0.10,...\n Statistical power:",mean(
p.values<0.05)),cex.main=1, cex.lab=0.75, cex.axis=0.75)
  # note that power is calculated estimating the proportion
  # of p.values that is less than 0.05 (i.e. assuming a two-sided 5% level of significance)
  segments(1:nsim,CIs[,1],1:nsim,CIs[,2],col="grey")
  abline(h=0.65,lty=2,col="green",lwd=3)
  abline(h=1,lty=2,col="red",lwd=3)
}
gimmePower(N=4000,OR=0.65,pY=0.10,nsim=1000)
```



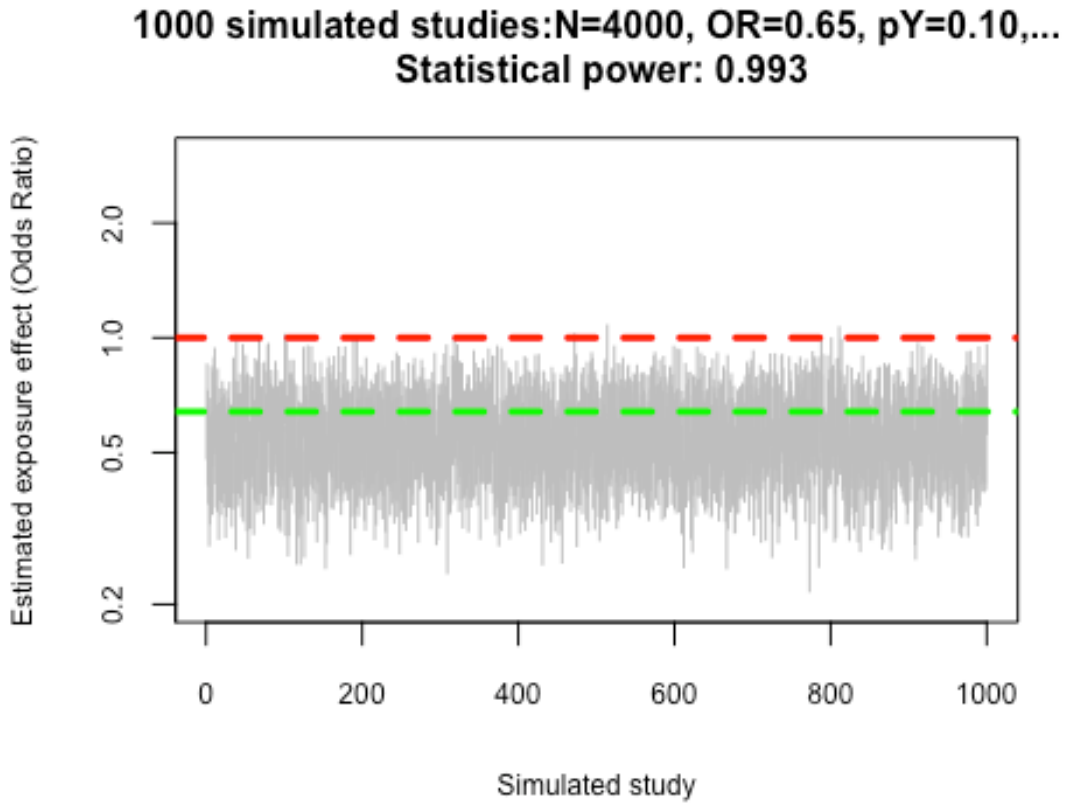
The simulation study results indicated minimum 4,000 observations that would provide 80% statistical power to reject the null-hypothesis of no exposure effect if the truly underlying exposure effect would be equal to an OR of 0.65 or higher (the assumed lower boundary of the exposure effect in the planned observational study).

Scenario 2: We completely remove the Confounder from the regression model to see how the Exposure estimate change. This removal yields 4.6% (Exposure OR=0.62) bias when estimating the exposure effect and artificially amplified statistical power of 21% (power increased from 0.79 to 1).

```
simdata3<-data.frame(IV,Exposure,Covariate,Outcome)
# fit a binary logistic regression model
fitlogisticmodel3<-glm(Outcome~IV+Exposure+Covariate,data=simdata3, family="binomial")
```

```
# Obtain summary fit statistics of the model. Note that the estimated coefficients are log Odds Ratios
summary(fitlogisticmodel3)

##
## Call:
## glm(formula = Outcome ~ IV + Exposure + Covariate, family = "binomial",
##     data = simdata3)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.4517  -0.4443  -0.4057  -0.3578   2.4602
##
## Coefficients:
##             Estimate Std. Error  z value Pr(>|z|)
## (Intercept) -2.265867   0.005750 -394.055  < 2e-16 ***
## IV           0.034911   0.007527    4.638 3.51e-06 ***
## Exposure    -0.485737   0.009049  -53.676  < 2e-16 ***
## Covariate   -0.224931   0.008387  -26.820  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 559057  on 999999  degrees of freedom
## Residual deviance: 555178  on 999996  degrees of freedom
## AIC: 555186
##
## Number of Fisher Scoring iterations: 5

# Obtain ORs from the estimated log ORs and compute 95% confidence intervals for the estimated ORs.
ORs<-exp(fitlogisticmodel3$coef)
cbind(ORs,exp(confint(fitlogisticmodel3)))

## Waiting for profiling to be done...

##                 ORs     2.5 %    97.5 %
## (Intercept) 0.1037400 0.1025760 0.1049143
## IV          1.0355275 1.0203624 1.0509164
## Exposure    0.6152436 0.6044130 0.6262384
## Covariate   0.7985715 0.7855377 0.8117915

gimmePower<-function(N=4000,OR=0.65,pY=0.10,nsim=1000)
{
 p.values<-rep(NA,nsim)
 ORs<-rep(NA,nsim)
 CIs<-matrix(NA,nsim,2)
 set.seed(123)
 for (i in 1:nsim)
 {
  fitlogisticmodel<-glm(Outcome~IV+Exposure+Covariate,data=simdat(N,OR), family="binomial") # r
un logistic model
  p.values[i]<-summary(fitlogisticmodel)$coef[3,4] # extract p-value
```

```
  ORs[i]<-exp(fitlogisticmodel$coef[3]) #extract estimated OR
  CIs[i,]<-exp(suppressMessages(confint(fitlogisticmodel)[3,])) # extract CI for OR
 }
 plot(c(1,nsim),c(0.2,3),type="n",log="y",xlab="Simulated study",ylab="Estimated exposure effect (Odd
s Ratio)",main=paste("1000 simulated studies:N=4000, OR=0.65, pY=0.10,...\n Statistical power:",mean(
p.values<0.05)),cex.main=1, cex.lab=0.75, cex.axis=0.75)
 # note that power is calculated estimating the proportion
 # of p.values that is less than 0.05 (i.e. assuming a two-sided 5% level of significance)
 segments(1:nsim,CIs[,1],1:nsim,CIs[,2],col="grey")
 abline(h=0.64,lty=2,col="green",lwd=3)
 abline(h=1,lty=2,col="red",lwd=3)
}
gimmePower(N=4000,OR=0.65,pY=0.10,nsim=1000)
```



One may use the slider function in R (package manipulate) to interactively adjust the input parameters of the function.

Step 6. Disseminating the results

We describe the details of the study codes and produced results which could be replicated by others.

CHAPTER 7: DISCUSSION

7.1 Summary of Research

In this dissertation, I conducted an in-depth investigation of potentially avoidable ED transfers and hospitalizations from LTC homes with a view of informing future observational study designs to assess the causal effect of a meaningful exposure existing under regular conditions (real-world) on reducing contextually and clinically relevant transfer outcomes using causal inference methods that would minimize bias. This work has yielded three manuscripts.

In the first manuscript, the systematic scoping review, I proposed a taxonomy for categories and components of interventions aimed at reducing acute care transfers from LTC homes including those that are 'potentially avoidable'. Among the 90 studies included in the review, I used the three following person-centred intervention dimensions to identify categories: 1) 'When/at what point(s)' on the continuum of care', 2) 'For whom', and 3) 'How' to effect change. I then identified six intervention categories: 'Advance care planning', 'Palliative & end-of-life care', 'Onsite care for acute/sub-acute/uncontrolled chronic conditions', 'Transitional care', 'Enhanced usual care', and 'Comprehensive care'. Finally, I classified interventions as consisting of one or more of the following four identified components: 'Increasing human resource capacity', 'Training or reorganization of existing staff', 'Technology', and 'Standardized tools'. While 'Enhanced usual care' was the most frequently reported intervention category, 'Increasing human resource capacity' was the most common intervention component. These findings informed my causal diagram for the data simulations manuscript as it prioritized advance care planning as the intervention category exposure and identified potential confounders of the relationship between our exposure and transfers from LTC to acute care.

My second manuscript was a cross-sectional study that reported on potentially avoidable ED transfers and hospitalizations for conditions that are *clinically manageable* in the context of the Quebec LTC setting. Results showed that the quantification of potentially avoidable ED transfers, being those transfers that either did or did not result in hospitalization, was an essential metric in terms of its ability to capture potential avoidable transfer events from LTC. This finding informed my data simulations manuscript as it prioritized potentially avoidable ED transfers as the primary outcome measure. I also showed, for the first time, that the prevalence of potentially avoidable ED transfer and hospitalizations in the province of Quebec were similar to those reported

for the rest of Canada. Proportions of transfers due to congestive heart failure, urinary tract infection, and implanted device management were different in the Quebec sample.

In the third manuscript, I addressed confounding that challenges the analysis and interpretation of results from non-randomized studies. Using the LTC context as a motivating example, I demonstrated the utility of data simulations to reduce confounding bias in estimating exposure effects. I described what data simulations were, demonstrated the step-by-step implementation of a Monte-Carlo study, and showed ways of exploring of how bias and variation in sample size affect inference. The results provided actionable clues on how to design the observational study protocol. Specifically, simulation results confirmed that our proposed confounders were important to account for in our analyses, and that an increase in sample size would be required (either by increasing the number of LTC homes or study period duration. This manuscript also provided guidance for other possible study designs (e.g., care-control and nested case-control studies) where this simulation study can be adapted.

Overall, through the presentation of these three manuscripts, I have contributed to the improvement of approaches for the evaluation of the effectiveness/efficacy of interventions that aim to reduce acute care transfers in this setting. I proposed a taxonomy of interventions, the first of its kind, as a global call to harmonize terminology on this topic. I provided substantive results pertaining to potentially avoidable acute care outcomes in a local LTC setting. I have demonstrated the value of adopting an innovative and comprehensive strategy to design an observational study using a causal inference framework with data simulations, a novel contribution for this context. My thesis contributed to the idea that observational studies have great value, especially when they are designed optimally, and can be the preferred strategy when the resources to conduct an RCT are unavailable.

7.2 Implications for Clinical Practice and Policy

I situated my thesis within an interdisciplinary context, maintaining the lens of person-centred care within the CIHI's LTC framework.[36] While primary care physicians are commonly responsible for the delivery of first-line health care to LTC home residents, specialist nurses or nurse practitioners may also deliver first-line primary care, often with delegated clinical responsibility.[140] My research therefore provides a novel strategy and evidence advancing the knowledge not only within the discipline of primary care but also for transitions between LTC and secondary/tertiary care

settings. The results of this research will inform a broad audience at the international, national, provincial, and local levels.

My systematic scoping review was the first to propose a taxonomy of intervention categories and components aiming to reduce both ED transfers and/or hospitalizations (all and/or potentially avoidable) from LTC with a focus on conditions that are *manageable* in LTC. Given that interventions found in this review were complex in that they were comprised of multiple and interacting components, this proposed taxonomy will inform future intervention designs and, by extension, potentially influence **clinical practice** both in Canada and elsewhere. This review also called for action to resolve the extreme heterogeneity in populations, interventions, comparators, and outcome measures in the LTC transfers literature. My recommendations for harmonizing research terminology and methodology in this research area will enable future literature reviews to synthesize intervention effectiveness and efficacy for each proposed category, thereby increasing confidence in future evidence for **policy-making**.

The cross-sectional study had implications at both national and provincial levels as this thesis was also the first to show detailed data on potentially avoidable ED transfers and subsequent hospitalization patterns from LTC in the province of Quebec and compare them to the other provinces in Canada. Though this was a study of seven public LTC homes, I believe that my thesis would have implications for improving both public and private LTC **clinical practice** and **policy** both in Quebec[141] and across Canada which has moved to the top of the social policy agenda following the COVID-19 pandemic.[142]

In Quebec, 'The Community of Practice of Physicians in LTC homes' was officially launched in Montreal, in November 2020.[143] This community provides a place for communication between physicians, sharing resources, and dissemination of best practices related to COVID-19 in LTC settings.[143] Nurse practitioner practice in LTC homes has also been gaining ground in Quebec, and the introduction of nurse practitioners in six LTC homes has shown important cost savings generated from the reduction of adverse events after its implementation.[144] At the national level, The College of Family Physicians of Canada & The Canadian Society for Long Term Care Medicine have both recommended the following urgent changes for LTC system improvement: Establishing national LTC standards, enhanced funding for staffing, family physician leadership in the medical director role at each LTC home, and effective and integrated communication for patient-centred care.[145] This dissertation has pointed out the importance of patient-centred care in

LTC homes by reiterating the value of ACP practices in the context of the pandemic and beyond. Potentially avoidable acute care transfers were operationalized using data extracted from an ED database as there were no other data available. Findings speak to the necessity for systematic surveillance, not only of potentially avoidable acute care transfers, but also of other individual and process level variables from LTC homes. The Continuing Care Reporting System[96] receives demographic, clinical, functional autonomy, and resource utilization information on individuals receiving services in LTC settings in Canada (InterRAI).[95,146] This system, to which Quebec has no commitment to participate, can facilitate this surveillance.

At the local Network level, findings indicated potentially established best practices for urinary tract infections while areas for improvement for practices in adjustment or replacement of implanted devices (such as gastric tubes). The avoidability of these conditions, however, should be examined more closely from the perspective of LTC clinicians, residents, and families/legal representatives, and then, targeted with specific interventions as appropriate.

Finally, the outputs of my thesis are intended to be directly integrated within a protocol for an observational study that will aim to assess the impact of ACP on reducing potentially avoidable acute care transfers from the LTC setting. Findings from this thesis has supported the idea that advance care planning (ACP) is a pertinent, feasible, and potentially important exposure in this research area. This selection has implications for **clinical practice** by its potential to improve the quality of healthcare for this frail population at the national level, since the number of Canadians with dementia is expected to double by 2038, resulting in a tenfold increase in demand for LTC placement.[147] Advance care planning has indeed recently gained attention in Canada. In 2021, the Canadian Hospice Palliative Care Association developed a guide for ACP in partnership with the Strengthening a Palliative Approach in Long-Term Care (pan-Canadian team of health and social science researchers).[72] The planned observational study, therefore, exemplifies the importance of implementing person-centred care via ACP to document transitional care preferences in the event of deterioration in that resident's health.[57,148] Once this observational study is executed, findings can be translated into person-centred actions for LTC stakeholders for implementation. This could ultimately inform practice guidelines in this setting.

7.3 Implications for Research Methods

As mentioned in the first thesis manuscript, systematic reviews of the interventions aimed at reducing acute care transfers from LTC homes have been plagued with rampant heterogeneity in the literature which has impeded the potential for drawing meaningful conclusions about effectiveness or efficacy. Recently published reviews indicated that this problem persists. For instance, a 2022 review which provided an evaluation via narrative synthesis[149] sought to identify programs where allied healthcare personnel were the primary providers of the intervention. Their five categories of interventions were an amalgamation of what my taxonomy from the first manuscript classifies as being categories and components.[149] If my proposed taxonomy had been used, the involvement of advanced practice nursing, for example, would be considered as an 'Increasing human resource capacity' intervention component. Similarly, the INTERACT program would have been considered to fit within the 'Comprehensive care' intervention category, end-of-life care and condition specific interventions would have been categorized as belonging to the 'Palliative & end-of-life care' and 'Onsite care for acute, subacute, or uncontrolled chronic conditions' intervention categories, respectively. The proposed taxonomy in this thesis will therefore allow future systematic reviews to provide more precise evidence on the effectiveness and efficacy of intervention categories and components on specific effect measures.

Likewise, documented research protocols pertaining to interventions to reduce acute care transfers from the LTC setting also highlight the value of having a taxonomy that harmonizes terminology. For example, Carter et al. are conducting a stepped-wedge RCT to assess a multi-component intervention aimed at reducing unnecessary hospitalizations from LTC homes by empowering nursing and care staff to detect and manage early signs of resident deterioration (i.e., 'Onsite care for acute, subacute, or uncontrolled chronic conditions' category).[150] Another cluster RCT protocol is evaluating the impact of an intervention addressing the collaboration between nurses and physicians and aiming to help restructure and optimize the existing daily care routine on reducing hospital admissions (i.e., 'Enhanced usual care' category).[151] The protocol of Munene et al. implements a standardized LTC-ED care and referral pathway for LTC homes seeking transfer to ED, which optimizes the use of resources both within the LTC home and surrounding community, and measures the rate of transfers to ED from LTC (i.e., 'Transitional care' category).[152] With the availability of the taxonomy as described in this thesis, meta-analysis of

these intervention studies can be conducted by subgroups using harmonized terminology to appropriately pool their estimates of effect.

Potentially avoidable ED transfers with or without hospitalizations are seldomly measured in the literature, perhaps due to challenges with their measurement.[153] This thesis has demonstrated a method to quantify potentially avoidable ED transfers as an essential quality assurance measure for the frail LTC home population. Another important methodological implication of this thesis is its call for distinguishing between potentially avoidable conditions based on their being *preventable* vs. *manageable*. Preventing an occurrence of events is one thing, while managing an event in the LTC setting once it has occurred is another. This distinction too has implications for precision in terminology for future measurements.

Furthermore, this thesis has demonstrated the importance of conducting a thorough knowledge synthesis prior to constructing causal diagrams, which are usually established after discussions between the statistical analysts and other members of the research team, and sometimes with stakeholders – in ideal situations such as participatory research approaches. The data simulation study that showcased a data-driven approach to inform the design of a rigorous observational study represents pioneering innovation in the LTC research on potentially avoidable acute care transfers. This key contribution will be beneficial for future observational studies aiming to estimate the effects (of any exposure of interest on any LTC quality indicator as a model outcome) that would be susceptible to bias when using conventional analytical approaches. The directed acyclic graph presented in this study could serve as a template for future studies and be adapted to different study designs with other exposures and outcomes.

7.4 Future Research Directions

7.4.1 Systematic reviews and meta analyses using the proposed taxonomy

This dissertation opens the door to new and more focused areas of research. Following the taxonomy of interventions, next steps will involve investigating the efficacy (effectiveness) of interventions (exposures) that fall within one of the six proposed categories where components are homogenous, and outcomes are comparable. Although, there appear to be many opportunities for specific research questions and analyses, there has been an observed shift towards technology-based interventions in the context of the COVID-19 pandemic.[154]

The pandemic has led to a dramatic increase in the use of telehealth services, particularly with older adults, who are at highest risk of COVID severity and mortality. As a result, EDs, especially in North America, are now leveraging telehealth as a key tool in a variety of settings for COVID-19 and non-COVID related conditions. A report of EDs in the United States and Canada (Ontario) outlines one specific model illustrating how telehealth is being used to increase access and care for community-dwelling older adults during COVID-19.[155]

In LTC homes, however, a goal of telehealth is to determine if facilities can treat in place, or transfer, and a common approach is a provider-to-provider model where EDs consult directly with LTC providers. For example, a 2022 study protocol investigates adding telemedicine to standard care to enable timely medical consultation for LTC home residents in case of the development of an acute medical condition with the goal to reduce unnecessary hospital admissions.[156] Sunner et. al has recently published a study protocol for a stepped wedge cluster RCT evaluating the implementation of telehealth visual assessment in emergency care for people living in LTC homes.[157] This intervention is comprised of an initial phone call by LTC to the Aged Care Emergency service in the ED which responds with a protocol-guided visual telehealth consultation for clinical decision-making, a management plan agreed between all intervention stakeholders, an automated consultation summary letter to the LTC physician and staff, and a 24-hour follow-up phone call to the LTC.[157] These are some of the examples of current interventions under investigation, and, hence, systematic reviews of their impact will be invaluable to decision makers.[158]

7.4.2 Towards an observational study protocol – Recalling our preamble vignette

The observational study protocol that will be informed by the outputs of this dissertation will be derived from a large sample of LTC homes in the province of Quebec. Since this study will represent the first time that this data is collected in Quebec, I operationalized data collection via a comprehensive list of important individual-level variables (e.g., signs and symptoms at the time of transfers), process-level variables (e.g., communication practices occurred during transfers amongst LTC staff and families), and facility-level variables (e.g., characteristics and capabilities). I have prepared data collection plans from varying resources including 1) an ED administrative database, 2) LTC chart reviews, 3) Electronic pharmacy databases, and 4) Key informant interviews. Appendix C presents a tree diagram of data sources.

Considering the vignette presented in the preamble, this upcoming study will address a crucial aspect of personalized LTC care (i.e., ACP). In this planned observational study protocol, comprehensive data collection via detailed chart abstraction will ensure the availability of pertinent variables affecting the relationship between ACP and potentially avoidable ED transfers. This will ultimately contribute to a better understanding of how potentially avoidable transfers are affected by ACP and how they could be aligned with residents' and families' needs and expectations. In addition, ACP appears to be feasible to implement. For example, the Caplan ACP intervention study included in the scoping review[159] reported statistically significant reductions in both ED transfers and hospitalizations while it did not require additional human resources.

Whereas use of the ambulatory care sensitive condition approach to define potentially avoidable hospital transfers is straightforward for research purposes, that which is not taken into consideration is the variability on an individual facility-level to provide various diagnostic tests and treatments onsite. Recent studies report that hospital transfers are often initiated by nurses.[160,161,162] This implies that physicians are unavailable at the time the decision was being rendered, and suggests a potential for reducing transfers by increasing physician presence. To account for these characteristics, a structured data collection form (Appendix D) was adapted to the Quebec context using a published list,[164,] the literature,[163,164] and the opinion of the LTC physician member of my thesis committee. After executing the study protocol and analyzing the data, findings will be consolidated by specific methods. An example of such methods was described in a 2021 study where ED and LTC physicians independently classified all ED visit diagnoses as potentially avoidable and then met to reconcile their lists through discussions to reach a consensus.[165]

7.4.3 Investigating geographical variations

It is expected that, the LTC homes in our planned observational study will provide a relatively representative sample of facilities providing 24-hour nursing care because of their varying sizes and different characteristics and capabilities such as staffing, diagnostic tests, and treatment availability. The sample, however, may not be sufficient to explain geographical variations in our transfer outcomes. The occurrences of hospitalizations can be a function of both to individual institution characteristics as well as the healthcare system in which LTC homes operate. In the United States, rates of hospitalization differed significantly between larger geographical areas and regions as well as between smaller geographical areas and within smaller regions.[166] Compared

with LTC homes located in urban areas, facilities in smaller towns and in isolated rural areas had significantly higher in-hospital deaths (a proxy outcome measure for avoidable hospitalizations).[167] Long-term care residents were more likely to experience a preventable hospitalization if they resided in an area experiencing a primary care shortage, suggesting that regional variations in supply of physicians or physicians' decision-making may explain the variation.[168] This area of research should consider how geographical areas influence ED transfers regardless of subsequent hospitalization, especially in Canada.

7.4.4 Investigating sociocultural variations

While long-term care homes provide a broad range of services to different age groups, they predominantly care for adults aged 65 years and older with dementia.[169] Adult residents younger than 65 years of age may include persons who have suffered strokes, are developmentally disabled, have other chronic conditions rendering them dependent for their activities of daily living, and persons afflicted with early-onset dementia. The latter condition typically affects individuals between the ages of 45 and 64 years[170] and constitutes approximately 3% of persons with dementia.[171] A 2022 study from the USA reported that the rates of acute care transfers were highest among residents younger than age 60.[172] It has also been reported that male residents are more frequently transferred to hospital (ED transfer or hospital admissions) than females, and that male residents' advance directives were more commonly not followed appropriately.[173] With a view to enhancing person-centred care, future research may investigate different LTC population subgroups while considering specific sociocultural factors that can influence acute care transfer decisions.

7.4.5 Interventions aimed at improving transfer processes

It is important to note that, while the overarching focus of the thesis pertained to reducing avoidable ED transfers and hospitalizations, improving transfer *processes* is equally crucial. These processes would include safety, timeliness, efficiency, effectiveness, and resident-centred care through improved communication during these emergency transitions.[174] Acute care stays for LTC home residents can significantly impact their clinical and cost trajectories upon return to the LTC home.[26] Strategies to mitigate functional decline of frail residents both in LTC and acute care settings should also be studied in parallel.[175] Indeed, the next phases of the larger review from which the dissertation systematic scoping review originated will entail synthesizing the literature

pertaining to both interventions aimed at improving the actual transitions of care from LTC home to acute care settings, once a transfer has been initiated, and conducting a meta-analysis of the interventions retained in our systematic scoping review, by intervention category sub-group.[73]

7.4.6 Implementation science research

A recent study has reported barriers and facilitators associated with implementing a comprehensive care intervention.[176] Additional qualitative studies evaluating the implementation of specific intervention categories are also needed. A synthesis of key intervention attributes (e.g., complexity), characteristics of stakeholders involved in implementation (e.g., personal beliefs, values, and attitudes), organizational factors (e.g., culture), and structural factors (e.g., health system)[177] is planned in our future work towards developing future intervention adaptations within our six taxonomy categories.[158]

Future research on complex intervention design (i.e., those that are comprised of multiple components) would benefit from the proposed taxonomy. Complex interventions sometimes may need to be adapted as new information comes to light. As such, researchers may consider adaptive study designs to investigate effective intervention options and variations at improving efficiency.[178] As well, it would be valuable to systematically measure intervention implementation success (e.g., fidelity, acceptability) along with intervention effectiveness/efficacy. Such hybrid effectiveness-implementation designs[178] may ensure that interventions align with care contexts and cultures.

7.4.7 Further validation of the proposed taxonomy

This dissertation adopted a systematic and best available approach to develop the taxonomy within the context of feasibility, available resources, and time constraints. Based on a comprehensive systematic scoping review, the taxonomy was developed using an iterative process and an empirical-to-conceptual approach,[179] until consensus was reached between our multidisciplinary team members including methodologists and LTC clinician researchers. The proposed taxonomy, however, might benefit from further validation by an international network of researchers who might take on this work, to arrive at a consensus.[180]

7.5 Conclusion

Overall, this dissertation provides important insights into proactive models of person-centred care that could ultimately inform primary care practice guidelines in the LTC home setting. This dissertation highlights the value of observational studies with optimal designs within the context of reducing potentially avoidable ED transfers and hospitalizations from LTC homes. The three substudies are conducted via a systematic investigation of interventions aimed at reducing avoidable acute care transfers, identification of methodologically and clinically meaningful outcome measures, and priori explorations of how bias and variation in sample size affect inference in an observational study applying causal inference methods. The proposed taxonomy of interventions was recently published, and as such is readily available for future clinical implementation and research. The quantification of potentially avoidable ED transfers with or without hospitalizations is an essential quality assurance measure in the LTC population that should be the focus of future research. The illustration of data simulations offers a generic scheme for reducing confounding bias in estimating intervention effects. Findings have implications for this complex care setting that involve not only LTC practice and policy, but also other stakeholders involved in the management of transitions between care settings.

CHAPTER 8: THESIS REFERENCES

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CHAPTER 9: APPENDICES

APPENDIX A. ANNUAL ETHICS APPROVAL FOR SUBSTUDY 2

Centre intégré universitaire de santé et de services sociaux du Centre-Ouest-de-l'Île-de-Montréal
Québec

Annual Renewal- Harmonized

Titre du protocole : **Reducing avoidable acute care transfers from long-term care – Identifying strategies via knowledge creation and stakeholder engagement**

Project number(s): **2019-1580**
Nagano identifier: **PAACTPhase1**
Principal investigator: **Machelle Wilchesky**
Project's REB approbation date: **2019-02-21**
Form: **F9H-27435**
First submit date: **2022-02-07**
Last submit date: **2022-02-07**
Form status: **Form approved**

Review and Decision- Research Review Office

1. **WCMH Reseach Ethics Sub-Committees**
   Medical/Biomedical Committee (MBM)

2. **Renewal Period Granted:**
   2022-02-21 to 2023-02-21

3. **REB Decision:**
   Approved - REB delegated review
   Please note that this decision is valid for the following participating site(s):
   CIUSSS-COMTL
   Comments:

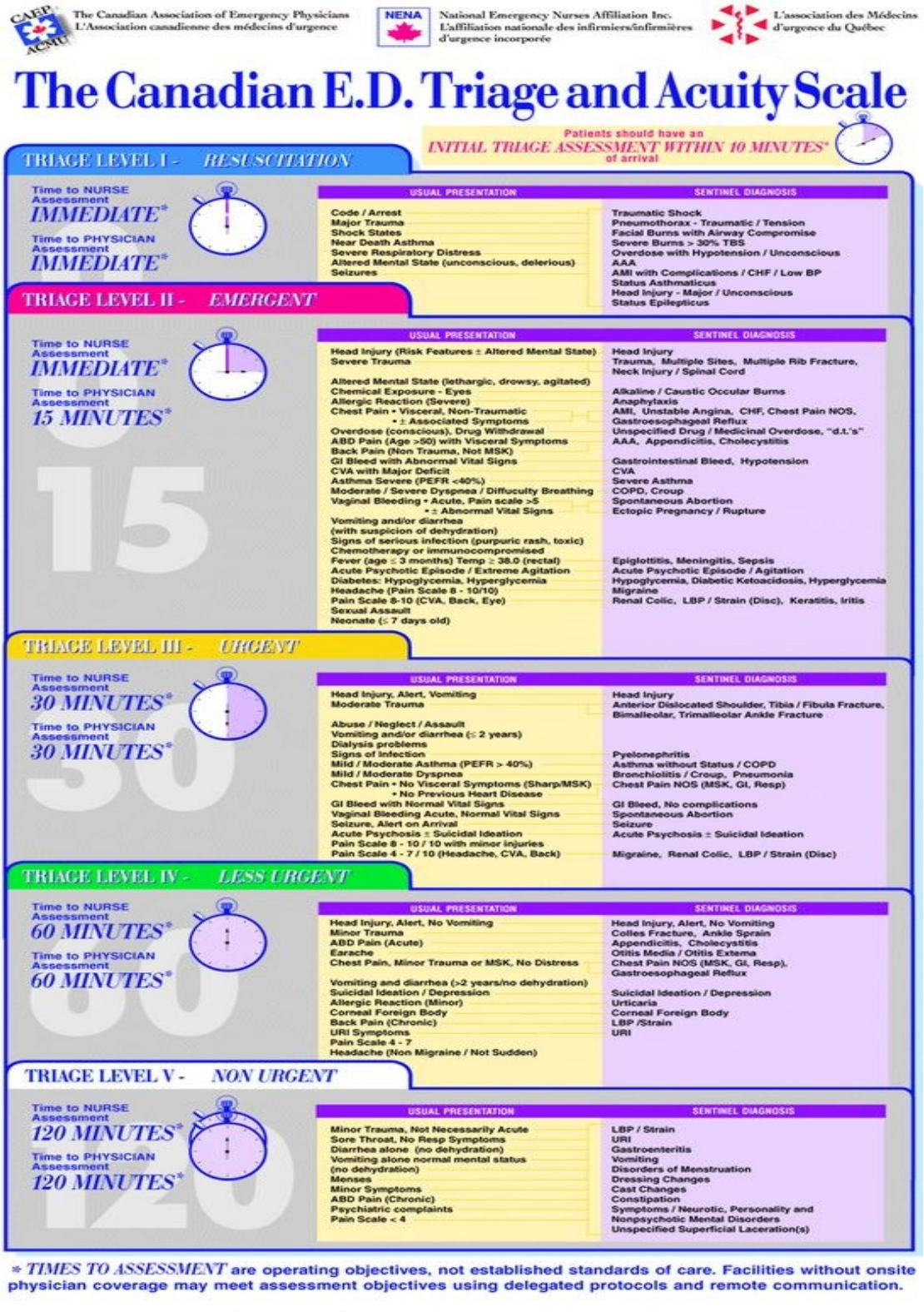
   Please note, if the timeline for collecting data, funding or study team changes please submit an amendment using the F1H form.

4. **Date of the REC final decision & signature**
   2022-02-24
   Signature

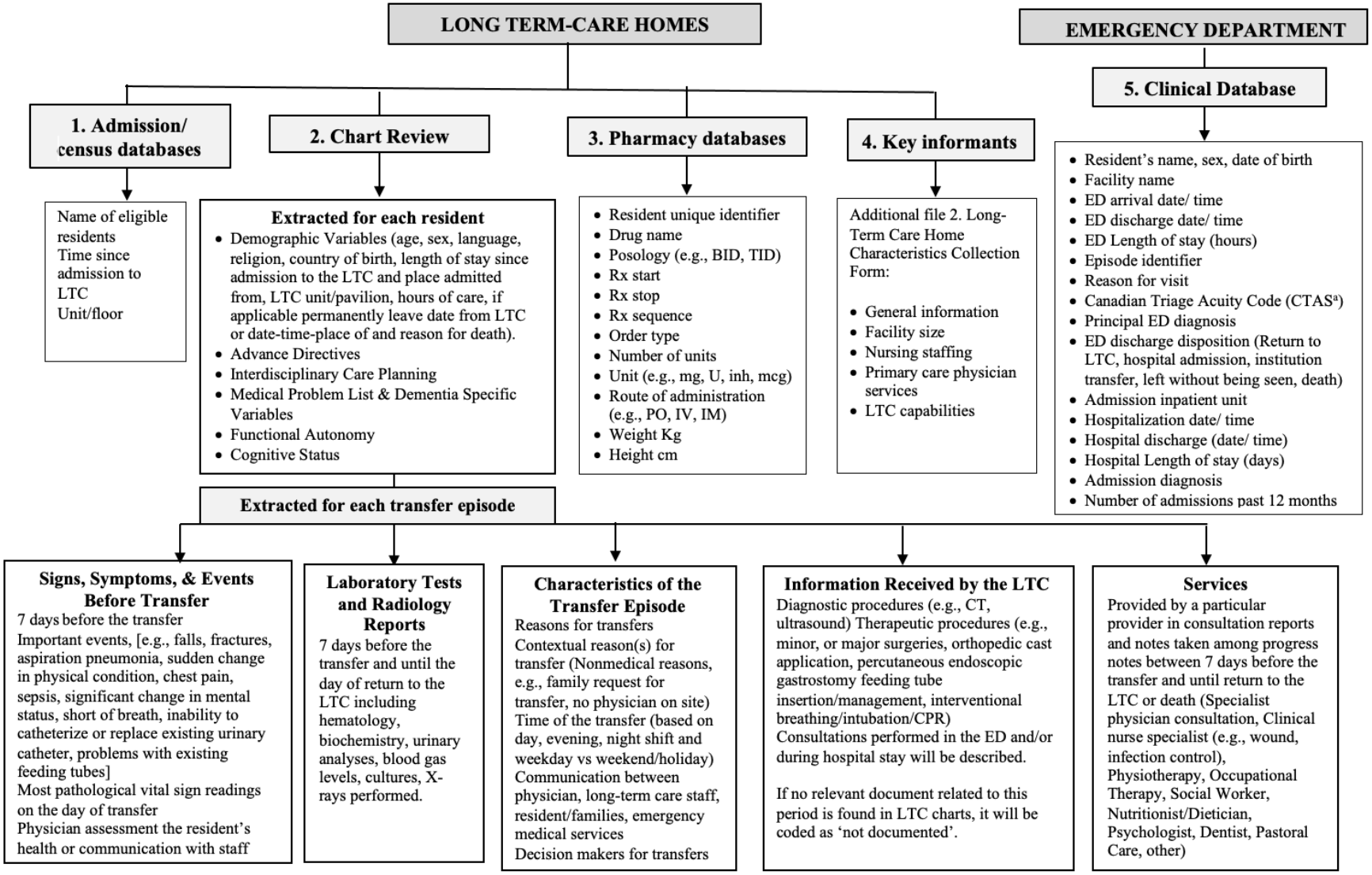
Dr. Vasiliki Bessy Bitzas, N, PhD, CHPCN(C)
Chair, Medical/Biomedical Research Ethics Committee

FWA 00000796

APPENDIX B. CANADIAN EMERGENCY DEPARTMENT TRIAGE AND ACUITY SCALE



APPENDIX C. TREE DIAGRAM: DATA SOURCES-VARIABLES FOR THE PLANNED OBSERVATIONAL STUDY



APPENDIX D. LONG-TERM CARE HOME CHARACTERISTICS COLLECTION FORM

A. GENERAL INFORMATION

1. LTC Home: _____
2. Date completed (YYYY/MM/DD): _____/ _____ /_____
3. Key informant's name: _____
4. Position: _____
5. Contact, in case clarifications needed: _____

Notes: _____

B. FACILITY SIZE

1. Number of long-term beds: _____
2. Number of rooms: _____
3. Special units: _____

Notes: _____

C. NURSING STAFFING

1. Total number of nursing

a. Number of Head Nurses: _____
b. Number of Registered Nurses (RN): _____
c. Number of Licensed Practicing Nurses (LPN): _____

Notes: _____

2. A Scheduled Shift Staffing (ASSiST) Measure (Cummings et al, 2017)

a. Number of orderly positions on average that are scheduled daily on the unit:			
	Monday - Friday	Saturday	Sunday
Days			
Evenings			
Nights			
b. Number of LPN positions on average that are scheduled daily on the unit:			
	Monday - Friday	Saturday	Sunday
Days			
Evenings			
Nights			
c. Number of RN positions on average that are scheduled daily on the unit:			
	Monday - Friday	Saturday	Sunday
Days			
Evenings			
Nights			

Notes: _____

D. PRIMARY CARE PHYSICIAN SERVICES

a. Physician (in LTC) positions on average that are scheduled daily on the unit:			
	Monday - Friday	Saturday	Sunday
Days			
Evenings			
Nights			
b. Physician (on call) availability on average that are scheduled daily on the unit:			
	Monday - Friday	Saturday	Sunday
Days			
Evenings			
Nights			

Notes: _____

E. LONG-TERM CARE HOME CAPABILITIES

a. Diagnostic testing	**YES**	**NO**
Stat lab tests with turnaround less than 8 hours	☐	☐
Stat X-rays with turnaround less than 8 hours	☐	☐
EKG	☐	☐
Bladder Ultrasound	☐	☐
Venous Doppler	☐	☐
Cardiac Echo	☐	☐
Swallow Studies	☐	☐
Other:	☐	☐
Notes:		
b. Therapeutic interventions	**YES**	**NO**
IV Fluids (initiation and maintenance)	☐	☐
IV Antibiotics	☐	☐
IV Meds – Other (e.g., furosemide)	☐	☐
Peripherally inserted central catheter (PICC) Insertion	☐	☐
PICC Management	☐	☐
Total Parenteral Nutrition (TPN)	☐	☐
Isolation (for MRSA, VRE, etc…)	☐	☐
Surgical Drain Management	☐	☐
Tracheostomy Management	☐	☐
Analgesic Pumps	☐	☐
Dialysis	☐	☐
Advanced CPR (ACLS - Advanced Cardiac Life Support capability)	☐	☐
Automatic Defibrillator	☐	☐
Other:	☐	☐
Notes:		
c. Nursing services	**YES**	**NO**
Frequent vital signs (e.g., every 2 hours)	☐	☐
Strict intake and output (I&O) monitoring	☐	☐
Daily weights	☐	☐
Accuchecks for glucose at least every shift	☐	☐
INR	☐	☐
O2 saturation	☐	☐
Nebulizer treatments	☐	☐
Incentive spirometry	☐	☐
Other:	☐	☐
Notes:		
d. Pharmacy Services	**YES**	**NO**
Emergency kit with common medications for acute conditions available	☐	☐
New medications filled within 8 hours	☐	☐
Other:	☐	☐
Notes:		
e. Other Specialized Services	**YES**	**NO**
Other:	☐	☐
Notes:		
f. Consultations	**YES**	**NO**
Regular visits internal medicine	☐	☐

On call internal medicine	☐	☐
Geriatrician	☐	☐
Psychiatry	☐	☐
Geriatric psychiatrist	☐	☐
Cardiology	☐	☐
Pulmonary	☐	☐
Wound care	☐	☐
Dentistry	☐	☐
Other physician specialty consultations (specify):_____	☐	☐
Other physician specialty consultations (specify):_____	☐	☐
Frequency of annual physicals	☐	☐
Medical students/residents	☐	☐
Other:	☐	☐
Other:	☐	☐
Other:	☐	☐
Notes:		
g. Therapies on site	**YES**	**NO**
Physiotherapy	☐	☐
Occupational therapy	☐	☐
Respiratory	☐	☐
Speech	☐	☐
Recreational therapy	☐	☐
Music therapy/ pet therapy	☐	☐
Art therapy	☐	☐
Psychologist/psychotherapy	☐	☐
Pastoral/Rabbinic care	☐	☐
Nutritionist/Dietician	☐	☐
Social Work	☐	☐
Hair dressing	☐	☐
Sports	☐	☐
Outings/trips	☐	☐
Volunteers/sitters	☐	☐
Other:	☐	☐
Notes:		
h. Continuing education, what kind?	**YES**	**NO**
Seminars:	☐	☐
Continuing Medical Education:	☐	☐
Dedicated staff for education:	☐	☐
Medical rounds:	☐	☐
Education for residents and families:	☐	☐
Other:	☐	☐
Notes:		
h. Existence of an emergency care protocol	**YES**	**NO**
What kind?	☐	☐
Notes:		