

HEALTHCARE SERVICE UTILIZATION IN THE LAST 2 WEEKS  
OF LIFE: A POPULATION-BASED COHORT STUDY OF  
ONTARIO DECEDENTS

By

Danial Qureshi, HBSc.

A Thesis

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MSc. Thesis Supervisor:

Dr. Hsien Seow

MSc. Thesis Committee Members:

Dr. Hsien Seow

Dr. Gregory Pond

Dr. John You

Dr. Peter Tanuseputro

## Abstract

**Background:** Place of death is a commonly reported indicator for assessing palliative care quality, but does not provide details of healthcare service utilization at the end-of-life, such as acute care. In particular, early palliative care has shown to reduce acute care service use, but findings are mostly limited to cancer patients with few population-based data available.

**Objectives:** The purpose of this research is to: 1) explore place of care trajectories in the last 2 weeks of life in a general population and among distinct illness cohorts, and 2) investigate whether early versus late palliative care affects acute care use and other publically-funded services in the last 2 weeks of life.

**Research Design:** A retrospective population-based cohort study using linked administrative health data to examine all Ontario decedents between April 1<sup>st</sup>, 2010 and December 31<sup>st</sup>, 2012.

**Methods:** Descriptive statistics were used to examine place of care trajectories and service utilization trends in the last 2 weeks of life. Multivariable logistic regression analyses were conducted to assess in the 2 weeks before death: 1) the odds of using an acute care setting (yes/no), and 2) the odds of time spent ( $\leq 1$  week or  $>1$  week) in acute care settings among users.

**Results:** Overall, 235,159 decedents were identified. About 32% had cancer, 31% had organ failure, and 29% had frailty. Overall, 29% of decedents used a hospital two weeks before death, but this increased to 61% on the day of death. Those with cancer were the largest users of

palliative-acute hospital care, while those with organ failure were the largest users of acute-hospital care. Assessing palliative care timing, 27% were early palliative care recipients, 13% were late. About 45% of early recipients had a community-based palliative care initiation, 74% of late recipients had a hospital-based initiation. Late recipients were more likely to use acute care settings; this was further modified by disease: comparing late to early recipients, cancer decedents were nearly two times more likely to spend >1 week in acute care settings (OR=1.84, 95% CI:1.83-1.85), frailty decedents were three times more likely (OR=3.04, 95% CI:3.01-3.07), and organ failure decedents were four times more likely (OR=4.04, 95% CI:4.02-4.06).

**Conclusion:** Place of care trajectories differ greatly by disease cohort. Exploring place of care trajectories can provide details not evident when reporting solely place of death. Furthermore, early palliative care was associated with reduced acute care service use in cancer and non-cancer patients. Late initiations were associated with greater acute care use, and had the largest effect on those with organ failure and frailty, suggesting potential opportunities for improvement in non-cancer populations.

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Submitted to: Palliative Medicine

Status: under peer review

*The contributions of Danial Qureshi to all of the papers in the thesis include: contributing to the research ideas and questions, performing the statistical analyses, interpretation of results, writing of all manuscripts, submission of all manuscripts, and responding to reviewers' comments. This research was conducted between September 2017 and May 2018.*

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## **CHAPTER 1: INTRODUCTION**

This chapter provides a brief introduction to end-of-life care. It specifically highlights current issues surrounding end-of-life care, and identifies several important knowledge gaps in recent literature. The major research questions related to this thesis work are also included.

### **End-of-Life Care**

‘End-of-life care’ and ‘palliative care’ are terms that have been used synonymously throughout most literature related to healthcare, death, and the dying experience. However, the World Health Organization defines palliative care as “an approach that improves quality of life of patients and their families facing the problems associated with life-threatening illness, through the prevention and relief of suffering by means of early identification and impeccable assessment and treatment of pain and other problems (physical, psychosocial and spiritual).”[1] Contrastingly, the Canadian Institute for Health Information (CIHI) refers to end-of-life care as “care for people in decline who are deemed to be terminal or dying in the foreseeable (near) future” and it “tends to be broader than palliative care, in that it includes any type of care – respite, home care, etc.” [2] Modern definitions of end-of-life and palliative care have emphasized the importance of analgesia to help cope with both psychological and physical symptoms of pain, while stressing the significance of shared-decision making that allows patients, family and friends to be active participants in care provision during the dying process.[3] Traditionally, the onus of end-of-life and palliative care provision was predominantly that of religious establishments and charity organizations, however, given the substantial rise in the proportion of deaths due to chronic and advanced illnesses—such as cancer, organ failure, or frailty— the role of healthcare providers and

medical institutions have become increasingly important for delivering quality care to these patients.[4]

## **Current Issues in End-of-Life Care**

Many reports discuss the growing need to improve end-of-life care services, and highlight the disparities that exist in accessing quality care among the dying. The quality of end-of-life care has become an important topic among policymakers and health system planners, who understand that dying patients are not only the most vulnerable individuals in society, but are among the highest users of healthcare services at large. Medical advancements have resulted in a demographic transition that has contributed to the increase in longevity, but has also led to increased comorbidities among the dying. Thus, it is essential for the healthcare system to quickly adapt to the needs of a growing number of palliative populations in order to achieve the best possible outcomes.

### *Health Care Costs at the End-of-Life*

In Canada, a substantial proportion of health care resources are consumed at the end of life. Health care expenditures are significantly skewed, with a small share of the population disproportionately consuming these vital resources. In Ontario, one-third of the government's health care costs are spent on only 1 percent of the population.[5] Similar evidence from Manitoba displays this imbalance further, as decedents (1.1% of the population) were found to consume 21.3% of health care costs in their last six months of life.[6] A large portion of these costs stem from hospital-based services that are thought to be consumed inappropriately at the end-of-life,

and often times are unnecessary for many patients. A recent report by the Institute of Clinical Evaluative Sciences found that hospital costs accounted for the greatest portion of total healthcare expenditures (median=\$1,973, 10<sup>th</sup> percentile=\$1,648, 90<sup>th</sup> percentile=\$2,469).[7] Use of hospital-based services also goes against the major preference of most patients experiencing advanced illness, who express a wish to receive care and die at home. Consequently, Canadian policymakers and health system planners have tried to formulate solutions that would result in cost savings from decreased use of unneeded and untimely treatments provided in inappropriate settings – especially for cancer populations.[8, 9] However, non-cancer patients have also contributed greatly to healthcare expenditures, with several studies indicating that the type of illness (cancer or non-cancer) responsible for death acts as a major predictor of functional decline over time.[8-10]

### *Quality of End-of-Life Care*

Quality indicators are well-defined and measurable outcomes of practice performance within a certain realm of care and for a specified patient population. End-of-life quality indicators have been increasingly used to gauge the quality of palliative care being delivered to those with chronic and advanced illness.[11] Previous literature has identified health service quality indicators that are important to quality care at the end of life, which include: place of death, emergency department visits, acute care service use, hospice referrals and more.[11] Given that most end-of-life patients prefer to die at home, place of death in particular has been extensively studied over the past few decades.[12-19] [20-23] However, policymakers increasingly want to know what services are being used by patients during the last few weeks of life, questioning the value of using place of death as an outcome since it only provides information about where individuals are dying. Additionally, assessing acute care service use has gained a lot of attention

by policymakers worldwide; most end-of-life discussions do not occur until the last few weeks of life, when one's condition has significantly deteriorated. As a result, acute care services are heavily used to manage these complex cases. Delivery of early palliative has shown many benefits in cancer patients, which include reduced acute care service use. However, research is limited for palliative care populations with other illnesses and conditions. Despite numerous calls to improve end-of-life care and decision making among cancer and non-cancer patients[24-26], little progress has been made in the past few decades to address such issues.[27, 28]

## **Addressing the Gaps**

Although informative, place of death as a quality indicator is limited in that it does not provide an accurate depiction of a patient's journey through the healthcare system at the end of life. Recognizing the kinds of services that patients use before death provides a better understanding of whether or not they are accessing the best resources required to improve their quality of end-of-life care. This calls for a more comprehensive approach that provides details about end-of-life service utilization, which cannot be accomplished solely by indicators such as place of death.

### *Research Questions*

This thesis paper aims to address current knowledge gaps in end-of-life care research through two major questions:

- 1) How are end-of-life health care services utilized in the last 2 weeks of life, and does this differ by disease (cancer, organ failure, frailty)?

- 2) Does palliative care initiation time before death affect healthcare service utilization in the last 2 weeks of life, and is this modified by disease (cancer, organ failure, frailty)?

In order to address these research questions, a retrospective population-based cohort was conducted using linked administrative health data available from the Institute of Clinical Evaluative Sciences, to examine Ontario decedents between April 1<sup>st</sup>, 2010 and December 31<sup>st</sup>, 2012.

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## **CHAPTER 2: METHODOLOGY**

This chapter highlights the variables and databases used to answer the research questions in this thesis. It also provides a concise summary table (Table 2) showing the specific variables of interest and how each was operationalized for the purposes of this research. Furthermore, a concise description of the methodology used for each research question is presented, followed by a brief explanation of the major methodological challenges encountered.

### **Using Health Care Administrative Databases**

Administrative data has been widely used to conduct meaningful retrospective studies, and a large portion of health information in Ontario is collected and stored in these linked databases. Such data provides a plethora of information regarding patient care such as age/sex demographics, hospital record data, inpatient and outpatient physician billings, palliative care administrations, vital statistics such as facility of death and more. The Institute for Clinical Evaluative Sciences (ICES) has managed this data across Ontario, taking the necessary precautions to ensure anonymity and privacy of all the linked administrative data they have stored. The Ministry of Health and Long-term Care has funded ICES in order to maintain this data and help conduct health services research. For this thesis, several administrative databases were linked together using unique patient identifiers (health insurance numbers) by ICES. These include: The Discharge Abstract Database from the Canadian Institute of Health Information (CIHI-DAD), Ontario Health Insurance Plan database (OHIP), Registered Persons Database (RPDB), Vital Statistic Database from the Office of the Registrar General – Deaths (ORGD), Home Care Database (HCD), National

Ambulatory Care Reporting System (NACRS), Continuing Care Report System (CCRS), and the Statistics Canada Census database.

CIHI is a not-for-profit organization that provides an abundance of important health information regarding the Canadian health system and its users. The DAD, a database maintained by CIHI, captures administrative, clinical and demographic information pertaining to hospital discharges. In particular, the DAD provides data such as hospital admission date, discharge date, diagnosis type, postal code, age, sex and more. CIHI uses standardized codes from The International Statistical Classification of Diseases and Related Health Problems - 10<sup>th</sup> Canadian revision (ICD-10-CA) to systematically categorize data pertaining to diseases, injuries and cause of death.[1]

Accuracy of codes used in CIHI databases is contingent upon 2 components: diagnosis type and information type (procedural, diagnostic, and demographic). Diagnosis type pertains to how and when a diagnosis is made when a patient is hospitalized; this includes elements such as the most responsible diagnosis (referred to as MRDx), pre-admission and post-admission comorbidities, secondary diagnosis, external causes, and service transfer diagnoses.[1, 2] Hospitalizations provided with a palliative care approach have been identified using a previously derived comprehensive list of codes obtained from the DAD – see Table 1.[3, 4] The MRDx is considered to be coded more accurately than other diagnosis types.[5] Another component that affects coding accuracy is information type. This includes codes pertaining to demographic information (i.e. admission or discharge date, and age), procedural information (i.e. surgical repair of a fracture), and diagnostic information (i.e. diagnosis of neoplasms). [2, 5]

## **Summarized Methodology**

### *Research Question #1*

Research addressing question #1 involved an exploratory descriptive analysis to assess variations in place of care among the overall study population, and by disease cohort. Descriptive statistics were used to describe demographic characteristics (such as age, sex, income quintile, place of death, and more). Utilization trends were assessed through mean and median values (overall and among users) and line graphs for each place of care. Observations were made using the overall population, followed by exclusion of non-service users (among service users only); this proved useful for illustrating a rich description of the burden of care and resource use at the end-of-life.

### *Research Question #2*

Research addressing question #2 involved descriptive analyses similar to question #1, with the addition of regression analysis. Multivariable logistic regression analyses were conducted to assess the association between palliative care initiation time and acute care service use in the last 2 weeks of life, and this was modelled for each disease cohort. The focus of this research question involved comparing the effect of early versus late palliative care on end-of-life acute care use, and thus, calculation of odds ratios proved beneficial for this task. During the research process, other statistical tests were considered such as such as negative binomial regression (to display intensity of service use), zero-inflated negative binomial regression (accounting for zeroes, or non-users of services), poisson regression, and addition of interaction terms. However, these options did not

prove useful and were deemed inappropriate given the nature and purpose of this research. See Figure 1 for an illustration of the conceptual framework pertaining to this research question.

## **Methodological Challenges**

### *Place of Care*

During the last 2 weeks of life, utilization of the following healthcare services was examined: 1) palliative-acute hospital care, 2) acute hospital care, 3) emergency department, 4) complex continuing care, 5) long-term care (i.e., nursing home), 6) home care, 7) home-based physician visit, 8) outpatient physician encounter, 9) and no health services. At the end-of-life, patients often use more than one of these services on any given day (i.e. receiving homecare shortly after being discharged from hospital). However, identifying one service for a particular day (where a patient had the longest duration of stay) was important for addressing research question #1. Thus, to avoid overlap with health sectors on a given day, a hierarchy was constructed in which healthcare services were ranked according to highest resource use and general importance (rank number highlighted above for each service). Through this hierarchy approach, the most ‘dominant’ place of care was illustrated for each of the last 14 days of life. Total utilization (inclusion more than one service on a given day) was assessed separately as well (no hierarchy applied). These methods allowed for a more informative descriptive analysis for research question #1.

### *Palliative Care Initiation Time*

In this research, patients initiating palliative care in their last year of life were examined. Patients were grouped into the following categories, according to palliative care initiation time

before death: early (60 or more days), late (15-59 days), very late (0-14 days), never (no initiation of palliative care). These groupings were chosen after conducting a sensitivity analysis; several variations in cut-off categories were explored (i.e. early as 6 months before death, etc.), including disease-specific cut-offs, but these did not significantly add to study findings. Furthermore, previous research on palliative care timing used similar categorizations for early and late palliative care groups.[6-12]

Another issue was whether or not to include the ‘very late’ palliative care group in the final analyses. Initially, the ‘very late’ palliative care recipients were included in the major study analyses, but it was determined that they should be excluded as this group introduced confounding biases. Inclusion of the very late group was not appropriate as patients in this group had an exposure period that overlapped with the outcome period (i.e. exposure: palliative care initiated in the 2 weeks before death, outcome: place of care in the last 2 weeks of life). Thus, it would be unclear if palliative care was initiated prior to or after use of a particular care setting within the last 2 weeks of life.

Table 1: Codes used to identify palliative care provision in acute care hospital settings

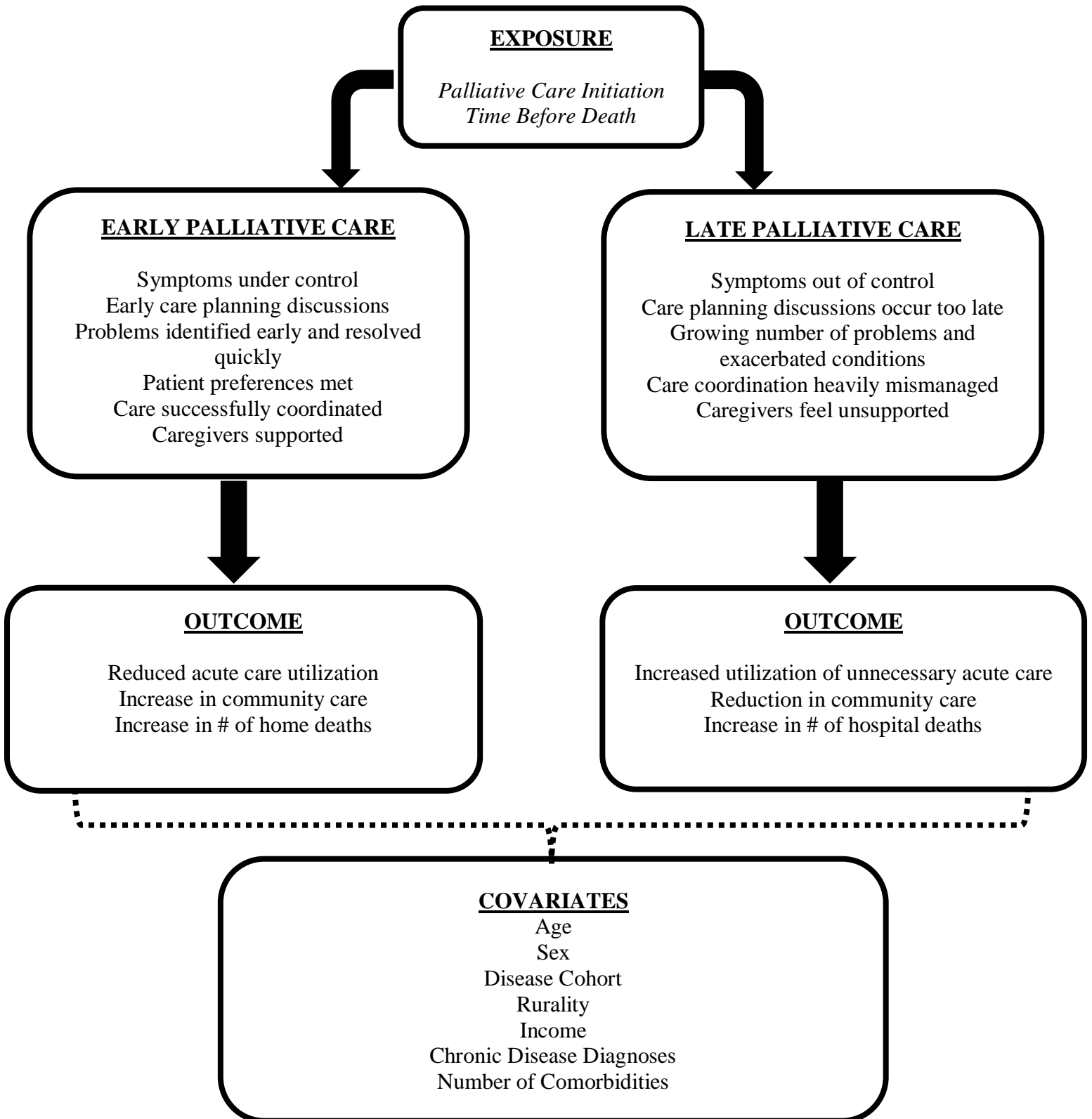
<b>Acute Hospital Admissions with Palliative Care Involvement</b>
Hospital Codes (Data Source: CIHI-DAD): <ul style="list-style-type: none"><li>• ICD-10 Code: Z51.5 and ICD-9 Code: V66.7: Any diagnosis of “palliative” as the main or contributing reason for admission</li><li>• PATSERV=58: main patient service of “palliative care” was responsible for care</li><li>• PRVSERV [1-8] or INSERV[1-20]=00121: “palliative medicine” was a provider who provided service, or an intervention service code of palliative medicine was provided</li></ul>



Table 2: Detailed list of study variables, definitions, and data sources

<b>Variables of Interest</b>	<b>Type of Variable</b>	<b>Variable Definition</b>	<b>Data Source</b>
Disease Cohort	Categorical	0 (Terminal Illness); 1 (Organ Failure); 2 (Frailty); 3 (Sudden Death); 4 (Other)	ORGD (w/ ICD-10 codes)
Age	Continuous	Date of birth to date of death	RPDB
Sex	Dichotomous	0 (Male) or 1 (Female)	RPDB
Income Quintile	Categorical	1 (Lowest) - 5 (Highest)	Statistics Canada
Rurality	Dichotomous	Y (Rural); N (Urban)	Statistics Canada
Chronic Disease(s)	Dichotomous	Hypertension, Osteoarthritis, Cancer, Diabetes, Congestive Heart Failure, Congestive Heart Disease, Dementia, COPD, Renal Disease (Y/N)	ORGD
# of Comorbidities (Charlson Score)	Categorical	0 (0); 1 or 2 (1-2); 3, 4 or 5 (3-5); 6 or greater ( $\geq 6$ )	ORGD
Place of Death	Categorical	H (Hospital); L (Long-term Care); C (Community)	ORGD
Palliative Care Initiation Time Before Death	Categorical	E (Early: $\geq 60$ days); L (Late: $\geq 15$ and $< 60$ days); V (Very Late: $\geq 0$ and $< 14$ days); N (Never: no initiation)	ORGD, CIHI-DAD, CCRS, HCD, OHIP
Palliative Care Initiation Sector	Categorical	H (Hospital); L (Long-term Care); C (Community)	ORGD, CIHI-DAD, CCRS, HCD, OHIP
<b>Outcome</b> <i>Place of Care in the Last 2 weeks of Life</i>			
Acute Care Settings -Palliative-acute care -Non-palliative-acute care	Count	# of acute hospital days / per day / patient	CIHI-DAD
Emergency Department	Count	# of ER visits/ per day / patient	NACRS
Subacute Care	Count	# of complex continuing care days / per day / patient	CCRS
Long-term Care	Count	# of long-term care days / per day / patient	CCRS
Home Care	Count	# of home care days / per day / patient	HCD
Home-based Physician Visits	Count	# of physician home visits / per day / patient	HCD
Outpatient Physician Encounters	Count	# of outpatient physician encounters / per day / patient	OHIP

Figure 1: Conceptual framework of pathway for the effect of palliative care initiation time on end-of-life service use in the last 2 weeks of life



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## **CHAPTER 3: RESEARCH QUESTION #1**

### *Place of Care Trajectories in the Last 2 Weeks of Life: A Population-based Cohort Study of Ontario Decedents*

This chapter addresses research question #1. A revised manuscript (presented below) was submitted to the Journal of Palliative Medicine.

#### **Abstract**

**Background/Objectives:** Place of death is a commonly reported indicator of palliative care quality, but does not provide details of service utilization near end-of-life. This study aims to explore place of care trajectories in the last two weeks of life in a general population and by disease cohorts.

**Design/Setting:** A retrospective population-based cohort study using linked administrative-health data to examine Ontario decedents between April 1<sup>st</sup>, 2010 and December 31<sup>st</sup>, 2012.

**Measurements:** Place of care trajectories in the last two weeks of life.

**Results:** We identified 235,159 decedents. 215,533 represented the major cohorts of our analysis—cancer (32%), frailty (29%), and organ failure (31%). 61% of all decedents died in hospital-based settings. Place of care utilization trends show us a marked increase in use of palliative-acute hospital care (13% to 26%) and acute hospital care (12% to 25%), and a small decrease in community care use (15% to 12%) in the last two weeks of life. Those with cancer

were the largest users of palliative-acute hospital care, while those with organ failure were the largest users of acute-hospital care.

**Conclusions:** Place of care trajectories show a marked rise in care in hospital-based settings from 29% to 61% in the last two weeks of life. Nearly half of all hospital deaths had palliative care as the main service provided. Place of care trajectories differ greatly by disease cohort. Exploring Place of care trajectories in the last two weeks of life can illuminate end-of-life utilization patterns not evident when reporting solely place of death.

## Introduction

In the past few decades, research on place of death has become extensively studied.[1-8] Research consistently shows that the majority of individuals prefer to die at home.[9-12] Place of death has been established as a valid indicator of end-of-life quality, with home deaths and avoidance of hospital-based deaths being considered outcomes of high quality end-of-life care. [13, 14]

An international study comparing place of death across 14 countries found that Canada was one of several countries which had the highest proportion of deaths occurring in hospital, for both cancer (67%) and non-cancer patients (59%).[15] A seven-country study of elderly patients dying with cancer found that Canada, had among the highest proportion of deaths in acute care hospitals, compared to the United States which had the lowest.[16] However, because of the international attention to support more patients at home during end of life, policymakers increasingly also want to know whether patients are spending more days at home and fewer days in hospital near end of life. Yet existing place of death research only provides information on where an individual was at the moment of their death. This means that a patient who experienced multiple transitions in their care setting within the last few weeks of life— such as moving between home, Emergency Department, and then to hospital—is undifferentiated from a patient who was well supported at home until the day of death, when he/she was then hospitalized for pain or symptom control. Moreover, policymakers want to know whether any hospitalizations were appropriate, but prior research has not described whether late-life hospitalizations were providing palliative care. There has been emerging research focusing on place of care and place of death as different concepts.[17, 18] These studies nonetheless, have limitations. Some only focus on cancer patients, lack a

population-based data source, or investigate particular health services (e.g. Emergency Department visits only). [19-27]

To address these knowledge gaps, we sought to examine the place of care trajectories in the last two weeks of life among Ontario decedents, including all health care services used in a publicly funded health system. We also examined how place of care trajectories in the last two weeks of life differ by individual disease cohorts (frailty, organ failure, and cancer). We particularly chose to observe the last two weeks of life because it is a time period in which end-of-life healthcare service utilization dramatically increases; especially the use of hospital-based services, which tend to peak in the last week of life.[28] This research would provide a more comprehensive understanding of where patients are receiving end-of-life care.



## Methods

### *Study Design & Data Sources*

We conducted a retrospective cohort study of Ontario decedents, capturing all deaths from April 1<sup>st</sup>, 2010 to December 31<sup>st</sup>, 2012. To identify all services used across several health sectors in the last two weeks of life, we used health card numbers to link multiple administrative databases held at the Institute for Clinical Evaluative Sciences. The databases included the: Vital Statistics Database (Office of the Registrar General – Deaths), which captured place, cause and date of death; Registered Persons Database, which captured all demographic information including sex, age and postal code; Ontario Health Insurance Plan Claims Database, which captured all claims data for physician services in both inpatient and outpatient settings; Home Care Database captured publically-funded home care services; Discharge Abstract Database captured acute hospital care with and without palliative care involvement (identified using a previously derived comprehensive list of palliative care billing codes)[29, 30]; National Ambulatory Care Reporting System captured all Emergency Department visits; Continuing Care Reporting System captured care provided in long-term care and complex continuing care (i.e. equivalent to sub-acute care settings); and Statistics Canada Census data captured income quintile and rurality via postal codes.[31]

Five distinct categories exist for causes of death: terminal illness (e.g. cancer), organ failure (e.g. chronic heart failure), frailty (e.g. Alzheimer's disease), sudden death (e.g. accident), and other [28, 32-34]; these have been validated in Canada.[28, 35] In this study, we refer to these categories as 'disease cohorts'. Decedents were assigned to a disease cohort based on the underlying cause of death code (ICD-10-CA diagnosis code – see Appendix I & II) found in the

vital statistics records. For clarity, we replaced the label ‘terminal illness’ with ‘cancer’ since the majority of individuals in this disease cohort had a cancer-related death. Note that decedents in the ‘sudden death’ and ‘other’ cohorts were excluded in our analyses due to their small numbers.

### *Outcome of Interest*

The primary outcome of interest was patients’ place of care trajectories among the last two weeks of life. Use of health care services by each patient during their last two weeks of life was identified and confirmed using billing records and fee codes. Based on having any record of health care service use in the last two weeks of life, decedents were categorized according to the following hierarchy for place of care (to control for any potential overlap of sector use): 1) palliative-acute hospital care, 2) acute hospital care, 3) emergency department, 4) complex continuing care, 5) long-term care (i.e., nursing home), 6) home care, 7) home-based physician visit, 8) outpatient physician encounter, 9) and no health services. Using this hierarchy, a patient using both a home care service and a home-based physician visit on the same day would be categorized as a home care user for that specific day due to the order of ranking. Within acute hospital settings, place of care on any given day during the last two weeks of life was counted as a palliative care day (i.e. deemed palliative-acute hospital care) for the entire duration of stay when: a decedent had a pre-admitting condition listed as palliative care or the most responsible diagnosis for the hospital stay was also palliative, the main service provider was palliative, or palliative care was consulted for the largest portion of their hospital stay. For all remaining palliative-acute hospital care encounters, only a single day of the hospitalization was counted as a palliative care day (e.g. individuals initially admitted as acute care patients but later received a palliative diagnosis at some point

during their hospital stay). This approach captures officially and unofficially designated palliative care unit beds in hospital. Note that when we use the term ‘hospital-based care’, we are referring to hierarchy rankings 1-4, and when using the term ‘community-based care’, we are referring to rankings 6-8 (i.e. not long-term care).

### *Statistical Analysis*

Descriptive statistics were used to compare cohort characteristics across the entire study population, and by disease. These characteristics include: sex, age, income quintile, rurality, chronic diseases, number of comorbidities, and place of death. Using our hierarchy approach, we graphed place of care trajectories of the overall study population, showing the number of people in a particular setting on a day-by-day basis within the last two weeks of life. We also graphed individual place of care trajectories of three major disease cohorts (frailty, organ failure, and cancer), with no hierarchy intact, allowing us to visualize the total utilization of each place of care on a day-by-day basis within the last two weeks of life. Furthermore, we used mean and median statistics to describe place of care utilization in the last two weeks and last day of life. Ethics approval for this study was granted by the Ottawa Hospital Research Institute Ethics Board in Ottawa, ON, Canada.

## Results

We identified 235,159 decedents during the study period. Our cohort was grouped into several disease cohorts: 32% as cancer, 31% as organ failure, 29% as frailty, three-percent as sudden death, and five-percent as other (see Table 1). Decedents with cancer, frailty or organ failure comprised 215,533 (92%) of the study population. Decedent characteristics were similar across all disease cohorts, with the exception of those in the frailty cohort (they had higher proportions of older females) and those in the sudden death cohort (they were younger with fewer comorbidities). Among the overall cohort, approximately 80% of decedents were aged 65 years or older. 79% of decedents had three or more comorbidities with hypertension being the most prevalent disease, followed by osteoarthritis and cancer. Looking at disease cohorts, 68% of the organ failure cohort experienced a hospital-based death, followed by 66% of those with cancer, and 48% of those with frailty. The frailty cohort also had a higher percentage of long-term care deaths (35%). Furthermore, the cancer cohort had a considerably higher percentage of individuals dying in a community-based setting (27%) when compared to those with organ failure (14%) or frailty (17%).

Figure 1 displays the place of care trajectories for the entire study population (includes all five disease cohorts). Two weeks before death, 29% of decedents were in hospital-based care; this grew to 61% of decedents in hospital-based care on their day of death, of which 43% of those were determined as palliative-acute hospital care. In the last two weeks, palliative-acute hospital care and acute hospital care settings had the largest and sharpest rise in utilization (13% to 26%, 12% to 25% respectively). Generally, there was a gradual decline in the percentage of patients residing in a community-based care setting with each day closer to death.

Figure 2 illustrates the place of care trajectory for three major disease cohorts (frailty, organ failure, cancer) with no hierarchy intact. The cancer cohort had a considerably higher proportion of users for palliative-acute hospital care, complex continuing care and all types of community-based care services. In contrast, across the last two weeks of life, the organ failure cohort had the largest proportion of acute-hospital care users. The frailty cohort made up the lowest proportion of users of palliative-acute hospital care, acute hospital care, complex continuing care and all types of community-based care, while having the highest proportion of long-term care users. Among community-based care services, a home-based physician visit was the least utilized service for all three cohorts in the last two weeks of life.

Table 2 displays the utilization among users of the various places of care, comparing the last two weeks of life and day of death. 34% of the overall study population utilized acute hospital care (where no palliative care was provided) at least once in the last two weeks of life. Both long-term care users and complex continuing care users spent a large number of days in those settings (13.5 and 10.7 mean days, respectively). Palliative-acute hospital care and acute hospital care users also spent a large portion of the last two weeks of life in such settings (9.1 and 6.9 mean days, respectively). These trends were similar when examining each disease cohort separately. More than half of the overall study population used hospital-based care on their day of death. On the day of death, those with cancer comprised the largest proportion of palliative-acute hospital care users (38%), while those with organ failure and frailty comprised the largest proportion of acute-hospital care users (32% and 22%, respectively).

## Discussion

This study explores place of care trajectories in the last two weeks of life among the population-based cohort of decedents in Ontario, Canada. Only 29% of decedents were using hospital-based care two weeks before death, but this rose to 61% on day of death. Nearly half of that hospital-based care was palliative-acute hospital care. There are large disparities in the place of care trajectories by disease cohorts in the last two weeks of life. When comparing by disease cohort, those with cancer comprised the largest proportion of palliative-acute hospital care and complex continuing care users consistently throughout the last two weeks of life, whereas those with organ failure consistently comprised the largest proportion of acute hospital care users. The cancer cohort also consistently used more of all the community-based care services in the last two weeks of life. This is the first and largest population-based study that assesses place of care trajectories in the last two weeks of life of both cancer and non-cancer decedents, which will be directly relevant to other countries with publicly funded healthcare systems.

Our population-based results around place of death and increased late-life hospitalizations are similar to those found in other international samples. [27, 36-38] The proportion of individuals dying in Ontario hospital-based settings are similar to the Canadian rate[16] and other developed countries, such as Western Australia.[26] Several other studies examined multiple places of care at end-of-life. Seow et al. measured the effect of community-based palliative care teams on places of care in the last 30 days for cancer patients, but did not describe a population-based sample that included non-cancer patients.[23] Teno et al. described changes in places of care among Medicare beneficiaries, but focused particularly on annual differences in hospital and nursing home stays in the last three months of life.[25] Our study advances prior work by providing details about where

individuals receive end-of-life care across multiple hospital- and community-based settings in the last two weeks of life.

Examining place of care trajectories provides information that is beneficial for quality improvement purposes. For instance, our results show that most patients were in the home and community two weeks before death, but many transferred to a hospital setting closer to death, for a mean of 8.6 days. It is important to note that not all hospitalizations are inappropriate: nearly half of the hospitalizations were provided with palliative care. Improvement activities might focus on preventing late-life hospitalizations that did not involve palliative care, or on providing palliative care earlier or in community-based settings. The disparities we see among disease cohorts might be influenced by differential access to palliative care. Seow et al., recently examined variations in access to palliative care, and found significant disparities among disease cohorts. They found that: when compared to organ failure and frailty decedents, those with terminal illness (mostly cancer) were significantly more likely to receive any palliative care, received more hospital and community-based palliative care services, and initiated palliative care four times earlier.[39] These findings suggest that palliative care services are still being under accessed by those with organ failure or frailty, which might require enhanced provider education.[40, 41]

Our study has several limitations. First, using cause of death data to categorize decedents is an imperfect strategy since not everyone dying from a particular disease has the same trajectory of functional decline; unfortunately, we did not have additional data on functional status or symptom scores to examine place of care by functional trajectory and disease-specific cause of death separately. Moreover, our study does not provide an indication of the quality of care being

delivered, and only elaborates on place of care. Residential hospice was not included as a place of care setting since there is no central hospice database and thus cannot be linked with the other administrative data. About 3,000 individuals die in hospice each year (approximately one to three percent of overall deaths). However, most of these individuals use home care or palliative-acute hospital care – which is included in our study – before being admitted to hospice. We only include publicly-funded homecare services. While we used methods to account for palliative care days in acute hospital settings during the last two weeks of life, we were unable to determine the number of palliative care days received by individuals in designated palliative care units within other places of care such as long-term care, and complex continuing care. Future research should explore how place of care trajectories differ by local and geographical variations in palliative care provision; this can include rurality, access to palliative care, availability of hospital beds, and proximity to hospital care settings. It should also examine the impact of using community-based palliative care services among end-of-life patients on place of care and utilization.



## **Conclusion**

In conclusion, this study examined place of care trajectories at the end-of-life in a general population and by distinct disease cohorts. It showed a marked increase in use of hospital-based care from 29% to 61% of the population in the last two weeks of life. Beyond place of death information alone, place of care trajectories can inform policymakers who aim to reduce inappropriate hospital use and costs at end-of-life and support more patients at home.

## **Acknowledgements**

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Table 1: Cohort Characteristics by Disease Cohort

<i>Characteristic</i>	<i>Cancer</i>	<i>Organ Failure</i>	<i>Frailty</i>	<i>Other</i>	<i>Sudden Death</i>	<i>Total</i>
Overall	75,657 (32%)	72,363 (31%)	67,513 (29%)	11,784 (5%)	7,842 (3%)	235,159 (100%)
Sex						
Female	36,532 (48%)	37,992 (53%)	36,810 (55%)	6,489 (55%)	2,855 (36%)	37,992 (53%)
Male	39,125 (52%)	34,371 (47%)	30,703 (45%)	5,295 (45%)	4,987 (64%)	34,371 (47%)
Age						
<19	172 (.23%)	691 (1%)	47 (0.07%)	827 (7%)	435 (6%)	2,172 (1%)
19-44	1,886 (2%)	1,601 (2%)	479 (1%)	332 (3%)	2,636 (34%)	6,934 (3%)
45-64	17,765 (23%)	9,878 (14%)	5,931 (9%)	1,172 (10%)	2,637 (34%)	37,383 (16%)
65-84	40,832 (54%)	32,332 (45%)	26,462 (39%)	4,188 (36%)	1,456 (19%)	105,270 (45%)
≥85	15,002 (20%)	27,861 (39%)	34,594 (51%)	5,256 (45%)	678 (9%)	83,400 (35%)
Income						
Lowest	16,014 (21%)	17,288 (24%)	15,637 (23%)	2,545 (22%)	2,008 (26%)	53,492 (23%)
Low	15,931 (21%)	15,344 (21%)	13,634 (20%)	2,317 (20%)	1,626 (21%)	48,852 (21%)
Middle	14,698 (19%)	13,727 (19%)	13,059 (19%)	2,086 (18%)	1,474 (19%)	45,044 (19%)
High	14,621 (19%)	13,074 (18%)	12,884 (19%)	2,063 (18%)	1,358 (17%)	44,000 (19%)
Highest	13,996 (18%)	12,136 (17%)	11,850 (18%)	1,967 (17%)	1,258 (16%)	41,207 (18%)
Rurality						
Rural	11,231 (15%)	10,741 (15%)	9,558 (14%)	1,286 (11%)	1,211 (15%)	34,027 (14%)
Chronic Diseases						
Hypertension	51,454 (68%)	58,133 (80%)	54,140 (80%)	8,649 (73%)	2,838 (36%)	175,214 (75%)
Osteoarthritis	35,279 (47%)	37,066 (51%)	34,335 (51%)	5,848 (50%)	2,807 (36%)	115,335 (49%)
Cancer	70,383 (93%)	16,073 (22%)	12,938 (19%)	2,560 (22%)	913 (12%)	102,867 (44%)
Diabetes	23,783 (31%)	30,235 (42%)	23,964 (35%)	3,876 (33%)	1,324 (17%)	83,182 (35%)
Congestive Heart Failure	14,673 (19%)	32,266 (45%)	27,958 (41%)	4,113 (35%)	670 (9%)	79,680 (34%)
Coronary Heart Disease	18,006 (24%)	26,035 (36%)	28,039 (42%)	3,774 (32%)	896 (11%)	76,750 (33%)
Dementia	8,348 (11%)	20,610 (28%)	33,611 (50%)	4,056 (34%)	534 (7%)	67,159 (29%)
COPD	16,222 (21%)	24,553 (34%)	15,119 (22%)	2,590 (22%)	704 (9%)	59,188 (25%)
Renal Disease	14,247 (19%)	21,991 (30%)	15,970 (24%)	3,075 (26%)	680 (9%)	55,963 (24%)
# of Chronic Diseases						
0	348 (0.46%)	2,049 (3%)	1,649 (2%)	1,166 (10%)	1,791 (23%)	7,003 (3%)
1-2	17,884 (24%)	10,195 (14%)	10,818 (16%)	1,822 (15%)	3,249 (41%)	43,968 (19%)
3-5	40,344 (53%)	32,611 (45%)	31,499 (47%)	5,114 (43%)	2,153 (27%)	111,721 (48%)
≥6	17,081 (23%)	27,508 (38%)	23,547 (35%)	3,682 (31%)	649 (8%)	72,467 (31%)
Place of Death						
Hospital	49,631 (66%)	49,462 (68%)	32,395 (48%)	9,191 (78%)	3,347 (43%)	144,026 (61%)
Long-term Care	5,586 (7%)	12,888 (18%)	23,544 (35%)	1,539 (13%)	152 (2%)	43,709 (19%)
Community Care	20,438 (27%)	10,010 (14%)	11,573 (17%)	1,054 (9%)	4,342 (55%)	47,417 (20%)

Table 2: Place of care utilization by disease cohort (among users)

<i>Place of Care</i>	<i>Cancer</i>	<i>Organ Failure</i>	<i>Frailty</i>	<i>Overall</i>
Total # of Users	75,657 (32%)	72,363 (31%)	67,513 (29%)	235,159 (100%)
<b>Palliative-Acute Hospital Care</b>				
# of Users	35,250 (48%)	21,773 (30%)	11,884 (16%)	73,010 (31%)
Among Users: Mean Days, Median (IQR)	9.3, 9 (5, 15)	8.9, 9 (4, 15)	8.8, 8 (4, 15)	9.1, 9 (4, 15)
Among Users: % Using Service on Death Date	38%	27%	15%	26%
<b>Acute Hospital Care</b>				
# of Users	22,282 (28%)	29,296 (37%)	19,736 (25%)	79,226 (34%)
Among Users: Mean Days, Median (IQR)	6.6, 6 (2, 10)	7.2, 6 (3, 12)	6.7, 5 (2, 11)	6.9, 6 (2, 11)
Among Users: % Using Service on Death Date	18%	32%	22%	25%
<b>Emergency Department</b>				
# of Users	29,089 (28%)	38,220 (37%)	27,248 (26%)	104,659 (45%)
Among Users: Mean Days, Median (IQR)	1.8, 2 (1, 2)	1.7, 2 (1, 2)	1.7, 1 (1, 2)	1.7, 1 (1, 2)
Among Users: % Using Service on Death Date	5%	13%	13%	5%
<b>Complex Continuing Care</b>				
# of Users	11,285 (55%)	4,778 (23%)	3,442 (17%)	20,393 (9%)
Among Users: Mean Days, Median (IQR)	10.7, 14 (6, 15)	10.4, 13 (5, 15)	11.1, 15 (6, 15)	10.7, 14 (6, 15)
Among Users: % Using Service on Death Date	14%	6%	5%	5%
<b>Long-Term Care</b>				
# of Users	5,262 (10%)	17,117 (32%)	27,911 (52%)	53,268 (23%)
Among Users: Mean Days, Median (IQR)	13.5, 15 (14, 15)	13.3, 15 (13, 15)	13.8, 15 (15, 15)	13.5, 15 (14, 15)
Among Users: % Using Service on Death Date	6%	18%	34%	16%
<b>Home Care</b>				
# of Users	40,673 (50%)	20,844 (26%)	15,571 (19%)	80,658 (34%)
Among Users: Mean Days, Median (IQR)	6.9, 6 (2, 11)	5.3, 4 (2, 8)	5.5, 4 (2, 9)	6.1, 5 (2, 10)
Among Users: % Using Service on Death Date	19%	7%	6%	7%
<b>Home-Based Physician Visit</b>				
# of Users	18,999 (56%)	7,524 (22%)	6,617 (19%)	34,046 (15%)
Among Users: Mean Days, Median (IQR)	2.4, 2 (1, 3)	1.5, 1 (1, 2)	1.4, 1 (1, 1)	2.0, 1 (1, 2)
Among Users: % Using Service on Death Date	12%	5%	5%	3%
<b>Outpatient Physician Encounter</b>				
# of Users	54,899 (40%)	40,722 (30%)	30,032 (22%)	135,825 (58%)
Among Users: Mean Days, Median (IQR)	2.9, 2 (1, 4)	1.9, 1 (1, 2)	1.7, 1 (1, 2)	2.3, 2 (1, 3)
Among Users: % Using Service on Death Date	25%	19%	15%	2%
<b>No Health Services</b>				
# of Users	36,384 (32%)	34,981 (31%)	28,023 (25%)	112,097 (48%)
Among Users: Mean Days, Median (IQR)	6.0, 5 (3, 9)	8.8, 9 (5, 13)	10.0, 12 (6, 14)	8.5, 9 (4, 13)
Among Users: % Using Service on Death Date	6%	9%	14%	11%

Figure 1: Place of care utilization trajectories by disease cohort (overall)

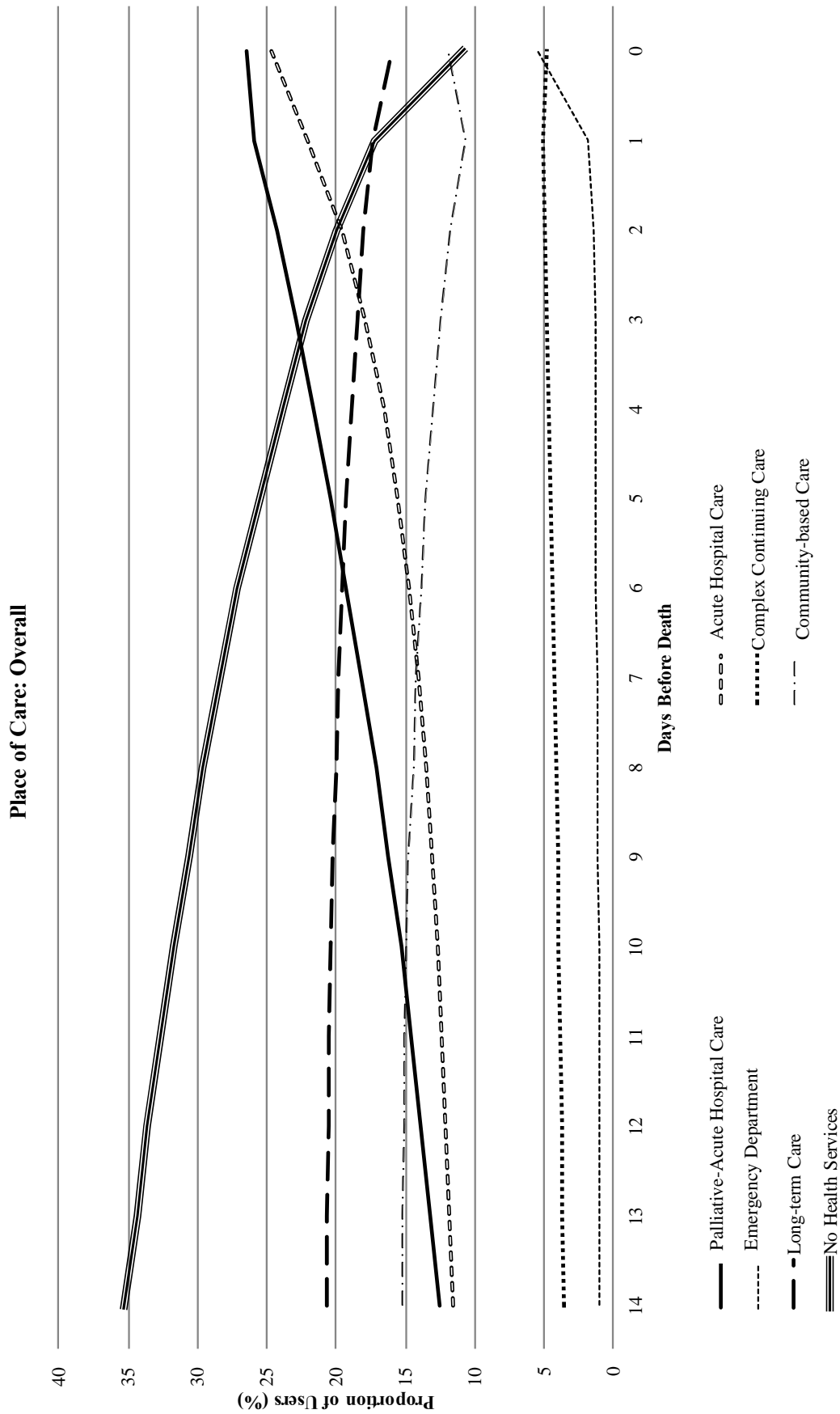
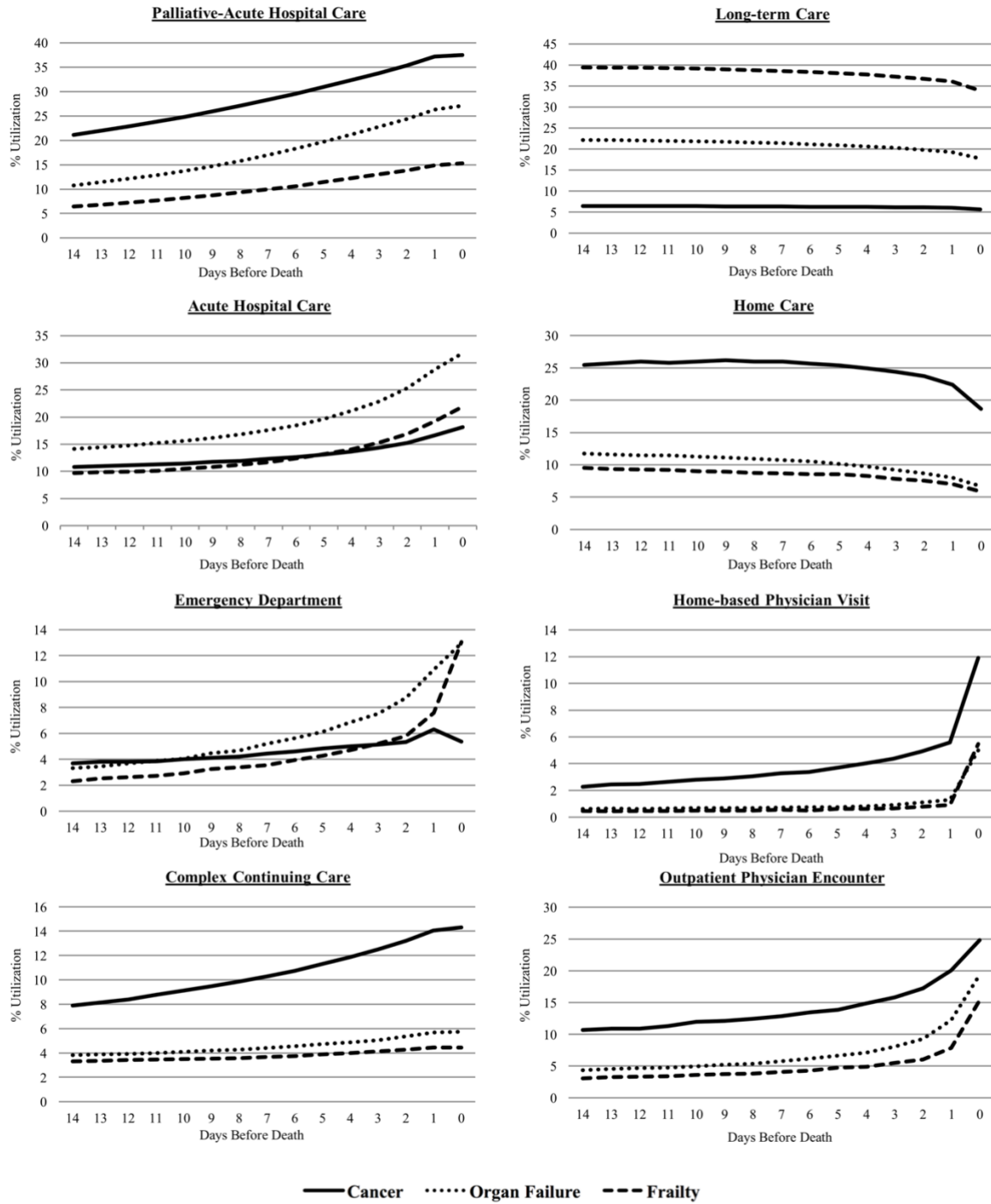


Figure 2: Place of care utilization trajectories by disease cohort (among users)



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## **CHAPTER 4: RESEARCH QUESTION #2**

### ***Early Initiation of Palliative Care is Associated with Reduced Late-Life Acute Care Hospital Use: A Population-based Cohort Study of Decedents in Ontario, Canada***

This chapter addresses research question #2. A manuscript (presented below) was recently submitted to Palliative Medicine.

#### **Abstract**

**Background:** Early palliative care can reduce end-of-life acute care use, but findings are mainly limited to cancer populations receiving exclusively hospital-based interventions. Moreover, few studies describe how early versus late palliative care affects end-of-life service utilization.

**Objectives:** To investigate the effect of early versus late palliative care (hospital or community-based) on acute care service use, and other publicly-funded healthcare services in the last 2 weeks of life.

**Design/Setting:** A population-based retrospective study using linked administrative data to examine Ontario decedents (cancer, frailty, organ failure) between Apr. 1st, 2010 and Dec. 31st, 2012. Decedents were grouped by initiation time before death: early ( $\geq 60$  days), late ( $\geq 15$  to  $< 60$  days). ‘Acute care settings’ included acute care hospital admissions with (‘palliative-acute care’) and without palliative involvement (‘non-palliative-acute care’).

**Measures:** The odds ratio (OR) of: 1) using an acute care setting (yes/no); and 2) spending  $> 1$  week in acute care settings among users (yes/no).

**Results:** We identified 235,159 decedents. 60% used acute care settings at least once in the 2 weeks before death. 27% were early palliative care recipients, 13% were late. 45% of early recipients had a community-based palliative care initiation, 74% of late recipients had a hospital-based initiation. Compared to late recipients, fewer early recipients used palliative-acute care (42% vs. 65%) with less days (mean days: 9.6 vs. 12.0), but similar non-palliative-acute care use. Late recipients were more likely to use acute care settings; this was further modified by disease: comparing late to early recipients, cancer decedents were nearly two times more likely to spend >1 week in acute care settings (OR=1.84, 95%CI:1.83-1.85), frailty decedents were three times more likely (OR=3.04, 95%CI:3.01-3.07), and organ failure decedents were four times more likely (OR=4.04, 95%CI:4.02-4.06).

**Conclusions:** Early palliative care was associated with improved end-of-life outcomes in cancer and non-cancer patients. In the 2 weeks before death, late initiations were associated with greater acute care use, and had the largest effect on those with organ failure and frailty, suggesting potential opportunities for improvement in non-cancer populations.

## Introduction

End-of-life discussions and interventions to control advanced symptoms often occur only during the last few weeks of life. This late initiation is often also associated with care that is primarily delivered in hospital settings – the default place of care when community-based care (i.e., in patient’s homes) is not established early and adequately. Palliative care that is earlier on in the course of one’s disease – and even concurrently with active treatments – can drastically improve symptom control, reduce distress experienced from standard therapies,[1-3] and can fulfill the wishes of many patients who prefer home-based care.[4-7] Consequently, policymakers have made a push towards supporting more patients at home during end-of-life – a widely used administrative indicator of end-of-life quality that also strives to reduce acute care service use.[8-11]

Past randomized controlled trials have illustrated that early palliative care is associated with better end-of-life outcomes.[12-14] For instance, a landmark study by Temel et al. demonstrated that early palliative care delivered concurrently with standard oncologic care was associated with improved quality of life, reduced depressive symptoms, longer survival rates, and less aggressive care at the end-of-life.[13] Although informative, results from these trials were limited to cancer patients who received hospital-based palliative care interventions. Recent research shows that community-based palliative care may also lead to improvements— such as, reduced acute care hospital use and hospital deaths— but never investigated the impact of early versus late palliative care on end-of-life service use, and mainly focused on small populations (mostly cancer) receiving care from a particular setting.[15-24] Furthermore, a large abundance of existing palliative care research uses late-life acute hospitalizations as an outcome to indicate poor

quality care. However, not all hospitalizations are considered inappropriate as some involve a palliative care approach; despite this, most research does not differentiate between those who did and did not receive palliative care in acute settings.

To address these knowledge gaps, we conducted a population-based retrospective cohort study of cancer and non-cancer Ontario decedents to investigate the effect of early versus late palliative care on acute care hospital use in the last 2 weeks of life. Our study specifically provides information on acute care hospital use with and without palliative care involvement during the hospitalization. We also report on all other end-of-life services used in a publicly-funded healthcare system, and assess disease-specific trends (frailty, organ failure, cancer). Our study advances prior work by investigating the effect of palliative care (both hospital and community-based) timing on end-of-life service use, which can inform other countries with similar or different health care systems.

## Methods

### *Study Design & Data Sources*

We conducted a retrospective cohort study of Ontario decedents aged 18 or older, capturing all deaths from April 1<sup>st</sup>, 2010 to December 31<sup>st</sup>, 2012. To identify all services used across several health sectors in the last 2 weeks of life, patient data was linked using multiple administrative databases held at the Institute for Clinical Evaluative Sciences, including the: Vital Statistics Database (Office of the Registrar General – Deaths), which captured place, cause and date of death; Registered Persons Database, which captured all demographic information including sex, age and postal code; Ontario Health Insurance Plan Claims Database, which captured all claims data for physician services in both inpatient and outpatient settings; Home Care Database, capturing publicly-funded home care services; Discharge Abstract Database, capturing all acute care use, including acute care with and without palliative care (identified using a previously derived comprehensive list of palliative care billing codes)[25, 26]; National Ambulatory Care Reporting System, which captured all Emergency Department visits; Continuing Care Reporting System, capturing care provided in long-term care and complex continuing care (i.e. equivalent to subacute care settings); and Statistics Canada Census data, which captured income quintile and rurality via postal codes.<sup>28</sup>

Five distinct categories exist for causes of death: terminal illness (e.g. cancer), organ failure (e.g. chronic heart failure), frailty (e.g. Alzheimer's disease), sudden death (e.g. accident), and other[27-29]; these cohorts have been previously used in Canada.[30, 31] In this study, we refer to these categories as 'disease cohorts'. Decedents were assigned to a disease cohort based on the



underlying cause of death code (ICD-10-CA diagnosis code) found in the vital statistics records, as defined previously.[30] For clarity, we replaced the label ‘terminal illness’ with ‘cancer’ since the majority of individuals in this disease cohort had a cancer-related death. Decedents in the ‘sudden death’ and ‘other’ cohorts were excluded in our analyses due to their small numbers, and because of the diminished potential role of palliative care in many cases.

### *Exposure*

The main exposure was time from first palliative care initiation to death from hospital or community, defined as the first instance of any palliative care service captured in the last year of life. We used a previously derived comprehensive list of palliative care billing codes to identify each individual’s date of palliative care initiation prior to death.[26] The timing of the exposure was calculated by finding the difference (in days) between an individual’s date of death and date of palliative care initiation. We categorized decedents into the following recipient groups, according to initiation time before death: **early** ( $\geq 60$  days), **late** ( $\geq 15$  to  $< 60$  days), **very late** ( $> 0$  to  $\leq 14$  days), and **never** (no initiation). Note that we mainly focus on comparing early versus late recipients, and exclude ‘very late’ recipients from much of our analyses; this was done to avoid confounding issues due to overlap with the outcome period (i.e. it would be unclear if palliative care was initiated prior to or after use of acute care within the last 2 weeks of life).

### *Outcomes*

The primary outcome was: use of acute care and community services during the last 2 weeks of life. We classified these services by care settings. Acute care settings were composed of: 1) ‘palliative-acute care’, defined as an acute care hospital admission that had palliative involvement, and 2) ‘non-palliative-acute care’, defined as an acute care hospital admission without any palliative involvement.[26] Other outcomes we examined include: subacute care, emergency department, and community-based care (home care, home-based physician visits, and outpatient physician encounters). Within acute care admissions, all days prior to discharge were counted as a palliative care day (i.e. deemed palliative-acute care) for the entire duration of stay when: a decedent had a pre-admitting condition listed as palliative care or the most responsible diagnosis for the hospital stay was also palliative, the main service provider was palliative, or palliative care was consulted for the largest portion of their hospital stay. For all remaining palliative-acute care encounters, only a single day of the hospitalization was counted as a palliative care day (e.g. individuals initially admitted as acute care patients but later received a palliative diagnosis at some point during their hospital stay). This approach indirectly captures designated palliative care unit beds in acute hospitals, and also palliative care services provided when another admitting service was the main provider service.

### *Statistical Analysis*

Descriptive statistics were used to compare cohort characteristics between early versus late palliative care recipients. Characteristics include: sex, age, income quintile, rurality, chronic

diseases, number of comorbidities, place of death, mean and median time to first palliative care initiation before death, and palliative care initiation sector. Multivariable logistic regression analyses were used to predict in the 2 weeks before death: the likelihood of using an acute care setting, and the likelihood of spending >1 week in acute care settings. We adjusted for the following covariates in the models: sex, age, income quintile, rurality, and number of comorbidities. Ethics approval for this study was received from the Ottawa Hospital Research Institute Ethics Board in Ottawa, Canada.

## Results

We identified 235,159 decedents during the study period, who spent an average of 5.1 days in acute care settings (of whom 60% had at least one service day in the last 2 weeks of life). Overall, 32% of decedents died from cancer, 31% from organ failure, 29% from frailty, 3% had a sudden death, and 5% from other causes. Almost half (46%) of decedents never received palliative care, and the remaining decedents were split by early palliative care (27%) and late or very late recipients (26%) (Table 1). The majority of early and late recipients died from cancer (67% and 53%, respectively), while a large portion of very late recipients died from organ failure (40%). Notably, more than half of cancer decedents were early recipients (56%). Overall, 61% of the study population experienced a hospital-based death, and more late recipients (73%) died in hospital compared to early recipients (60%) (Table 2).

### *Palliative Care Initiations*

Early recipients initiated palliative care at a mean time of 210 days prior to death, compared with a mean of 32 days for late recipients (Table 2). Overall, 45% of early recipients initiated in a community-based setting, which was almost two times greater than the proportion of late recipients (26%). Late recipients had considerably more hospital-based initiations (74%) when compared to early recipients (54%). Disease-specific differences show that organ failure and frailty decedents had the most hospital-based initiations (82% and 73%, respectively), while cancer decedents had the most community-based initiations (44%).

*Place of Care Utilization Trends (Among Service Users)*

About 63% of early recipients used an acute care setting at least once in the last 2 weeks of life (spent 9.2 mean days), compared to 80% of late recipients (spent 11.7 mean days) (Table 3). Early and late recipients had a similar proportion of non-palliative-acute care users (26% and 23%, respectively), with similar days of service use (6.4 and 6.8 mean days, respectively). Compared to late recipients, fewer early recipients used palliative-acute care (65% vs. 42%) and spent less service days (9.6 vs. 12 mean days) in the last 2 weeks of life. Additionally, early recipients made more use of community-based care, having almost double the percentage of individuals receiving home-based physician visits compared to late recipients (28% vs. 17%).

*Multivariable Analyses*

When examining the odds of using acute care settings, late recipients from each disease cohort have a higher OR (cancer: OR=2.31, 95%CI: 2.30-2.32, frailty: OR=3.05, 95%CI: 3.03-3.07, organ failure: OR=3.25, 95%CI: 3.23-3.27) compared to early recipients, controlling for covariates. (Table 4). Similarly, when examining the odds of spending >1 week in acute care settings during the last 2 weeks of life, late recipients have a higher OR (cancer: OR=1.84, 95%CI: 1.83-1.85, frailty: OR=3.04, 95%CI: 3.01-3.07, organ failure: OR=4.04, 95%CI: 4.02-4.06) compared to early recipients (Table 5). An increasing number of comorbidities was also associated with increased odds of using acute care settings, and increased odds of spending >1 week in acute care settings – especially for those with frailty. Table 6-8 displays additional logistic regression

analyses showing the influence of palliative care initiation time by disease cohort, and palliative care initiation time by location of initiation.

### *Place of Care Utilization Trajectories*

When observing utilization trajectories of hospital-based care in the last 2 weeks of life by early versus late initiation time, similar trends exist across the three disease cohorts (Figure 1). The proportion of early recipients using acute care settings increased as death got closer, but never reached as high a proportion as the late recipients, which stayed consistently high throughout the last 2 weeks. Palliative-acute care accounted for most of the acute care use for both early and late recipients.

## Discussion

To our knowledge, this is the first study of its kind that uses population-based data from a universal healthcare system to study the effect of early versus late palliative care on a rich set of services used at the end-of-life by both cancer and non-cancer patients. Our study findings show that early palliative care (as opposed to late palliative care) was associated with improved outcomes near the end-of-life. In the 2 weeks before death, early recipients had lower odds of using acute care and lower odds of spending >1 week in acute care compared to late recipients. Moreover, we found that early recipients made greater use of community-based services. Many early initiations occurred in a community-based setting, while late initiations occurred mainly in hospital. Early recipients had twice as many community-based deaths, and 13% less hospital-based deaths; early recipients were largely receiving out-of-hospital care, such as within the home, while most late recipients remained hospitalized throughout the last 2 weeks of life.

Reducing end-of-life acute care service use is an indicator of higher quality of care[32] while lowering healthcare costs.[33] Past research has also shown that early palliative care (defined variably, ranging from 1-6 months before death) is associated with reduced end-of-life acute care service use. Seow and colleagues previously conducted a population-based analysis of Ontario decedents, showing that early home-based palliative care reduced the risk of needing acute care in the last 2 weeks of life.[19] Several US cancer studies also highlight the benefits of early palliative care which include less aggressive at the end-of-life[13], fewer hospital admissions, and reduced hospital-based deaths[34] [35] Similarly in Western Australia, earlier community-based palliative care was found to reduce acute hospital stays[22], emergency department use[18], and unplanned hospitalizations.[23] Moreover, a Singapore study found that earlier referrals to

hospital-based palliative care was associated with a higher likelihood of dying out of hospital.[36] Several European studies also reach similar conclusions.[15] [37]

Frailty and organ failure decedents received a late initiation of palliative care more often than cancer decedents, which was also associated with poorer outcomes in the last 2 weeks of life. We found that frailty and organ failure decedents were three times and four times more likely, respectively, to spend a greater duration of time in acute care hospitals (compared to their early counterparts). A late initiation similarly influenced cancer decedents, but the effect was not as pronounced. Several factors may explain these findings. Firstly, non-cancer patients tend to receive lower quality end-of-life care than cancer patients.[38] Also, the setting of end-of-life care – which is known to be a key driver of disease-specific disparities[38]—may play a role; our data shows that late palliative care provided to organ failure and frailty decedents was initiated mostly in hospital, which may not necessarily be the most appropriate care setting. Non-cancer populations also experience greater incongruence between their care preferences and what happens in reality. Differences in trajectory of functional decline and its predictability may also explain our findings; for instance, patients with organ failure experience an end-of-life trajectory marked by acute exacerbations, warranting a greater need for acute care services.[28, 39] Therefore, earlier identification and increased understanding of patient needs may help improve palliative care provision; accomplishing this requires extensive knowledge of the trajectories of functional decline, existing comorbidities, and the social and environmental circumstances under which care is provided.



*Strengths and Limitations*

Past studies examine recipients of hospital-based palliative care or community-based services, but not both together. A major strength of this study is the inclusion of a population-based sample from Ontario, Canada, where patients rely on a universal health system where patients are provided with concurrent access to hospital and community palliative care services without needing to forego curative treatment. Unlike the US, where patients are required to forego curative care to be eligible for the Medicare Hospice Benefit at the end-of-life, we are able to observe palliative care provision in the entire population. Thus, our data is largely generalizable to other high-income countries with similar publically funded healthcare (i.e. UK, and Australia). Another strength of our study is that we include cancer and non-cancer decedents, and a large set of health sectors to observe various services used at the end-of-life. We also capture officially and unofficially designated palliative beds in acute care hospitals, allowing us to distinguish palliative- from non-palliative- acute care use; this information lets us gauge which end-of-life hospitalizations were appropriate or inappropriate, and serves as a useful comparator for other countries whose systems may or may not allow for such distinctions to be made.

Our study has several limitations. First, our study does not address the quality of care being delivered, nor do we describe the intensity of palliative care services provided in acute hospitals. Second, residential (i.e. free-standing) hospice facilities were not included as a place of care setting due to the lack of a central hospice database. About 1-3% individuals die in hospice annually, though most who do so use services such as home care or palliative-acute care – which is included in our study – before being admitted to a hospice. Moreover, our study only includes home care

services that are publically-funded. Lastly, our findings may be susceptible to indication bias; patients initiating late palliative care are often close to death with more unstable conditions, and thus, more likely to receive care in acute settings at the end-of-life. However, our study's objective was not to evaluate impact of initiation times, but instead, to assess associations.

## **Conclusion**

In conclusion, this study demonstrates that early palliative care is associated with reduced acute care hospital use (with or without palliative involvement) in the last 2 weeks of life. Clear disparities exist in palliative care timing, with organ failure and frailty decedents receiving late palliative care more often than early. These findings suggest that non-cancer populations might reap greater benefits if identified earlier for palliative care, which may also help reduce costly end-of-life acute care service use. Future research should examine effective interventions that would allow for earlier identification of patients (including cancer and non-cancer) who may benefit from timely palliative care.

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Table 1: Cohort characteristics by palliative care initiation time before death

<i>Characteristic</i>	<i>Early</i>		<i>Late</i>		<i>Very Late</i>		<i>Never</i>		<i>Overall</i>	
	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>	<i>N</i>	<i>%</i>
Overall	62,925	27	29,789	13	31,626	13	108,590	46	235,159	29
Disease Cohort										
Frailty	7,901	12	5,234	8	8,205	12	45,499	67	67,513	29
Organ Failure	11,196	15	7,514	10	12,543	17	40,088	55	72,363	31
Cancer	42,337	56	15,695	21	8,431	11	8,881	12	75,657	32
Sudden Death	168	2	165	2	348	4	7,125	91	7,842	3
Other	1,323	11	1,181	10	2,099	18	6,997	59	11,784	5
Sex										
Female	32,174	27	14,971	12	16,791	14	55,548	46	120,678	51
Male	30,751	27	14,818	13	14,835	13	53,042	46	114,481	49
Age										
18-44	1,493	22	391	6	347	5	4,788	69	6,934	3
45-64	13,057	35	4,409	12	3,455	9	16,234	43	37,383	16
65-84	32,041	30	14,692	14	14,302	14	43,276	41	105,270	45
85+	16137	19	10218	12	13445	16	42636	51	83400	35
Income										
Lowest	13,393	25	6,529	12	7,351	14	25,705	48	53,492	23
Low	13,152	27	6,319	13	6,676	14	22,235	46	48,852	21
Middle	12,024	27	5,823	13	5,966	13	20,840	46	45,044	19
High	12,170	28	5,669	13	5,922	13	19,809	45	44,000	19
Highest	11,888	29	5,276	13	5,473	13	18,189	44	41,207	18
Rurality										
Urban	54,126	27	25,822	13	27,243	14	90,523	45	199,642	85
Rural	8,708	26	3,899	11	4,293	13	16,858	50	34,027	14
Chronic Diseases										
Hypertension	45,197	26	22,551	13	25,053	14	80,676	46	175,214	75
Osteoarthritis	31,552	27	14,666	13	15,877	14	52,118	45	115,335	49
Cancer	47,876	47	18,543	18	12,452	12	23,353	23	102,867	44
Diabetes	21,735	26	10,398	13	11,380	14	38,875	47	83,182	35
Congestive Heart Failure	18,305	23	9,415	12	12,273	15	38,882	49	79,680	34
Coronary Heart Disease	18,422	24	9,088	12	11,127	14	37,312	49	76,750	33
Dementia	12,143	18	7,162	11	10,102	15	36,972	55	67,159	29
COPD	15,866	27	7,373	12	9,005	15	26,393	45	59,188	25
Renal Disease	14,714	26	7,402	13	9,248	17	24,026	43	55,963	24
# of Chronic Diseases										
0	183	3	201	3	350	5	6,202	89	7,003	3
1-2	12,415	28	5,381	12	4,746	11	21,060	48	43,968	19
3-5	31,109	28	15,290	14	15,580	14	48,689	44	111,721	48
6+	19,218	27	8,917	12	10,950	15	32,639	45	72,467	31

Table 2: Place of death and palliative care delivery

<i>Characteristic</i>	<i>Early</i> <i>N=62,925</i>	<i>Late</i> <i>N=29,789</i>	<i>Very Late</i> <i>N=31,626</i>	<i>Never</i> <i>N=108,590</i>	<i>Overall</i> <i>N=235,159</i>
Place of Palliative Care Initiation (%)					
Hospital	54	74	83	N/A	35
Long-term Care	0.2	0.3	0.8	N/A	0.2
Community	45	26	16	N/A	18
Initiation Time Before Death (Days)					
Mean, Median (IQR)	210, 201 (116, 307)	32, 30 (21, 42)	6, 6 (3, 9)	N/A	114, 59 (13, 200)
Place of Death (%)					
Hospital	60	73	83	52	61
Long-term Care	11	10	11	28	19
Community	29	17	6	21	20

Table 3: Place of care utilization by palliative care initiation time (among users)

<i>Place of Care</i>	<i>Palliative Care Initiation Time</i>		
	<i>Early</i> (N=62,925)	<i>Late</i> (N=29,789)	<i>Never</i> (N=108,590)
<b>Care in Hospitals/Institutions</b>			
Acute Care Settings: Mean Days (% Users)	9.2 (62.5)	11.7 (79.8)	7.3 (44.6)
Non-Palliative-Acute Care: Mean Days (% Users)	6.4 (26.4)	6.8 (22.8)	7.3 (44.6)
Palliative-Acute Care: Mean Days (% Users)	9.6 (42.3)	12 (65.2)	0 (0)
Emergency Department: Mean Days (% Users)	1.8 (32.5)	1.6 (25.3)	1.6 (44.6)
Subacute Care: Mean Days (% Users)	11.3 (16.9)	9.6 (13.6)	12.2 (3.6)
Long-Term Care: Mean Days (% Users)	13.3 (11.6)	12.8 (9.9)	14.1 (32)
<b>Care in the Community</b>			
Home Care: Mean Days (% Users)	7.4 (55.4)	5.9 (42.5)	4.9 (19.2)
Home-Based Physician Visit: Mean Days (% Users)	2.4 (28)	2.1 (16.6)	1.1 (7.5)
Outpatient Physician Encounter: Mean Days (% Users)	2.9 (69.9)	2.8 (69.5)	1.6 (43.5)

Table 4: Multivariate logistic regression analysis: odds of ever using acute care settings

<i>Exposure</i>	<i>Ever Used Acute Care Settings (Odds Ratio 95% CI)*</i>					
	<i>Cancer</i>	<i>P-value</i>	<i>Frailty</i>	<i>P-value</i>	<i>Organ Failure</i>	<i>P-value</i>
<b>Palliative Care Initiation Time</b>						
Early	Ref.	<0.0001	Ref.		Ref.	
Late	2.31 (2.3, 2.32)	<0.0001	3.05 (3.03, 3.07)	<0.0001	3.25 (3.23, 3.27)	<0.0001
Never	0.96 (0.95, 0.97)	0.0672	0.52 (0.51, 0.53)	<0.0001	0.61 (0.6, 0.62)	<0.0001
<b>Sex</b>						
Male	Ref.		Ref.		Ref.	
Female	0.8 (0.79, 0.81)	<0.0001	0.66 (0.65, 0.67)	<0.0001	0.76 (0.75, 0.77)	<0.0001
<b>Age</b>						
18-44	1.88 (1.85, 1.91)	<0.0001	1.57 (1.51, 1.63)	<0.0001	1.41 (1.38, 1.44)	<0.0001
45-64	1.4 (1.39, 1.41)	<0.0001	1.06 (1.04, 1.08)	0.0905	1.16 (1.15, 1.17)	<0.0001
65-84	Ref.		Ref.		Ref.	
85+	0.6 (0.59, 0.61)	<0.0001	0.61 (0.6, 0.62)	<0.0001	0.52 (0.51, 0.53)	<0.0001
<b>Income</b>						
Q1	Ref.		Ref.		Ref.	
Q2	0.96 (0.95, 0.97)	0.1331	1.04 (1.03, 1.05)	0.1282	1.07 (1.06, 1.08)	0.0102
Q3	0.9 (0.89, 0.91)	<0.0001	0.97 (0.96, 0.98)	0.3046	1 (0.99, 1.01)	0.9754
Q4	0.9 (0.89, 0.91)	<0.0001	0.95 (0.94, 0.96)	0.0595	1.05 (1.04, 1.06)	0.1135
Q5	0.82 (0.81, 0.83)	<0.0001	0.94 (0.93, 0.95)	0.0319	1.02 (1.01, 1.03)	0.5514
<b>Rurality</b>						
Urban	Ref.		Ref.		Ref.	
Rural	1.11 (1.1, 1.12)	<0.0001	0.99 (0.98, 1)	0.6401	0.95 (0.94, 0.96)	0.0347
<b># of Comorbidities</b>						
0	Ref.		Ref.		Ref.	
1	3.45 (3.38, 3.52)	<0.0001	2.23 (2.18, 2.28)	<0.0001	1.76 (1.72, 1.8)	<0.0001
2	4.14 (4.07, 4.21)	<0.0001	3.07 (3.02, 3.12)	<0.0001	2.44 (2.41, 2.47)	<0.0001
3	4.77 (4.7, 4.84)	<0.0001	4.48 (4.44, 4.52)	<0.0001	2.97 (2.94, 3)	<0.0001
4	5.01 (4.94, 5.08)	<0.0001	5.86 (5.82, 5.9)	<0.0001	3.51 (3.48, 3.54)	<0.0001
5	5.52 (5.45, 5.59)	<0.0001	7.76 (7.72, 7.8)	<0.0001	4.36 (4.33, 4.39)	<0.0001
6	6.38 (6.31, 6.45)	<0.0001	12.03 (11.99, 12.07)	<0.0001	5.51 (5.48, 5.54)	<0.0001

\* Multivariable logistic regression was used to determine OR

Ref: Never Used Acute Care Settings

Table 5: Multivariate logistic regression analysis: odds of spending &gt;1 week in acute care settings

<i>Exposure</i>	<i>Spent &gt;1 Week in Acute Care Settings; Among Users (Odds Ratio 95% CI)**</i>					
	<i>Cancer</i>	<i>P-value</i>	<i>Frailty</i>	<i>P-value</i>	<i>Organ Failure</i>	<i>P-value</i>
<i>Palliative Care Initiation Time</i>						
Early	Ref.		Ref.		Ref.	
Late	1.84 (1.83, 1.85)	<0.0001	3.04 (3.01, 3.07)	<0.0001	4.04 (4.02, 4.06)	<0.0001
Never	0.77 (0.75, 0.79)	<0.0001	0.41 (0.39, 0.43)	<0.0001	0.48 (0.47, 0.49)	<0.0001
<i>Sex</i>						
Male	Ref.		Ref.		Ref.	
Female	1.06 (1.05, 1.07)	0.002	0.87 (0.86, 0.88)	<0.0001	0.87 (0.86, 0.88)	<0.0001
<i>Age</i>						
18-44	1.29 (1.26, 1.32)	<0.0001	1.52 (1.43, 1.61)	0.0158	1.06 (1.02, 1.1)	0.4911
45-64	1 (0.99, 1.01)	0.8555	0.88 (0.85, 0.91)	0.021	1.09 (1.07, 1.11)	0.0175
65-84	Ref.		Ref.		Ref.	
85+	0.95 (0.94, 0.96)	0.0701	0.84 (0.82, 0.86)	<0.0001	0.82 (0.81, 0.83)	<0.0001
<i>Income</i>						
Q1	Ref.		Ref.		Ref.	
Q2	1 (0.98, 1.02)	0.9495	0.97 (0.95, 0.99)	0.519	0.95 (0.93, 0.97)	0.1437
Q3	0.98 (0.96, 1)	0.6178	0.95 (0.93, 0.97)	0.2125	0.93 (0.91, 0.95)	0.0367
Q4	0.94 (0.92, 0.96)	0.063	0.99 (0.97, 1.01)	0.8684	0.96 (0.94, 0.98)	0.3008
Q5	0.95 (0.93, 0.97)	0.1166	0.92 (0.9, 0.94)	0.0479	0.88 (0.86, 0.9)	0.0007
<i>Rurality</i>						
Urban	Ref.		Ref.		Ref.	
Rural	1 (0.99, 1.01)	0.8931	0.92 (0.9, 0.94)	0.0443	0.91 (0.89, 0.93)	0.0033
<i># of Comorbidities</i>						
0	Ref.		Ref.		Ref.	
1	1.18 (1.06, 1.3)	0.4761	1.54 (1.44, 1.64)	0.028	1.13 (1.07, 1.19)	0.2895
2	1.37 (1.25, 1.49)	0.183	1.58 (1.49, 1.67)	0.0148	1.18 (1.13, 1.23)	0.1195
3	1.45 (1.33, 1.57)	0.1105	1.85 (1.76, 1.94)	0.0008	1.39 (1.34, 1.44)	0.0017
4	1.66 (1.54, 1.78)	0.0304	1.99 (1.9, 2.08)	0.0002	1.58 (1.53, 1.63)	<0.0001
5	1.57 (1.45, 1.69)	0.0543	2.23 (2.14, 2.32)	<0.0001	1.67 (1.62, 1.72)	<0.0001
6	1.74 (1.62, 1.86)	0.0184	2.53 (2.44, 2.62)	<0.0001	1.9 (1.85, 1.95)	<0.0001

\*\* Multivariable logistic regression was used to determine OR

Ref: Spent ≤ 1 Week in Acute Care Settings



Table 6: Multivariate logistic regression analysis (with exposure variable: disease cohort by palliative care initiation time)

	<i>Ever Used Acute Care Settings*</i> (Odds Ratio 95% CI)	<i>Spent &gt;1 Week in Acute Care Settings**</i> (Odds Ratio 95% CI)
<b>Disease Cohort by Initiation Time</b>		
<b>Cancer</b>		
Early	2.89 (2.86, 2.92)	2.28 (2.24, 2.32)
Late	6.69 (6.65, 6.73)	4.23 (4.18, 4.28)
Never	2.65 (2.6, 2.7)	1.75 (1.69, 1.81)
<b>Frailty</b>		
Early	2.07 (2.02, 2.12)	2.44 (2.37, 2.51)
Late	5.93 (5.86, 6)	7.32 (7.23, 7.41)
Never	Ref.	Ref.
<b>Organ Failure</b>		
Early	3.47 (3.42, 3.52)	2.59 (2.53, 2.65)
Late	11.28 (11.21, 11.35)	10.34 (10.26, 10.42)
Never	2.13 (2.1, 2.16)	1.25 (1.21, 1.29)
<b>Sex</b>		
Male	Ref.	Ref.
Female	0.75 (0.73, 0.77)	0.95 (0.92, 0.98)
<b>Age</b>		
18-44	1.75 (1.68, 1.82)	1.22 (1.13, 1.31)
45-64	1.3 (1.27, 1.33)	1.01 (0.97, 1.05)
65-84	Ref.	Ref.
85+	0.57 (0.55, 0.59)	0.86 (0.83, 0.89)
<b>Income</b>		
Q1	Ref.	Ref.
Q2	1.03 (1, 1.06)	0.98 (0.94, 1.02)
Q3	0.96 (0.93, 0.99)	0.96 (0.92, 1)
Q4	0.97 (0.94, 1)	0.96 (0.92, 1)
Q5	0.93 (0.9, 0.96)	0.92 (0.88, 0.96)
<b>Rurality</b>		
Urban	Ref.	Ref.
Rural	1.02 (0.99, 1.05)	0.95 (0.91, 0.99)
<b># of Chronic Diseases</b>		
0	Ref.	Ref.
1	2.49 (2.39, 2.59)	1.22 (1.05, 1.39)
2	3.18 (3.09, 3.27)	1.36 (1.2, 1.52)
3	3.92 (3.83, 4.01)	1.5 (1.34, 1.66)
4	4.52 (4.43, 4.61)	1.68 (1.52, 1.84)
5	5.51 (5.42, 5.6)	1.71 (1.55, 1.87)
6	7.48 (7.39, 7.57)	1.95 (1.79, 2.11)

\*Ref. = never used acute care settings

\*\*Ref. = ≤ 1 week in acute care settings

Table 7: Multivariate logistic regression analyses: odd of ever using acute care settings (with exposure variable: palliative care initiation time by location)

<i>Exposure</i>	<i>Ever Used Acute Care Settings (Odds Ratio 95% CI)</i>					
	<i>Cancer</i>	<i>P-value</i>	<i>Frailty</i>	<i>P-value</i>	<i>Organ Failure</i>	<i>P-value</i>
<b>Palliative Care Initiation Time by Location</b>						
Early (Hospital)	1.57 (1.53, 1.61)	<.0001	3.28 (3.18, 3.38)	<.0001	2.53 (2.44, 2.62)	<.0001
Early (Out-of-Hospital)	Ref.	-	Ref.	-	Ref.	-
Late (Hospital)	5.54 (5.47, 5.61)	<.0001	15.71 (15.58, 15.84)	<.0001	13.41 (13.29, 13.53)	<.0001
Late (Out-of-Hospital)	1.22 (1.16, 1.28)	<.0001	0.76 (0.59, 0.93)	0.0013	0.75 (0.61, 0.89)	0.0001
Never	1.19 (1.14, 1.24)	<.0001	1.14 (1.05, 1.23)	0.0033	1.15 (1.08, 1.22)	0.0002
<b>Sex</b>						
Male	Ref.	-	Ref.	-	Ref.	-
Female	0.8 (0.77, 0.83)	<.0001	0.67 (0.63, 0.71)	<.0001	0.76 (0.72, 0.8)	<.0001
<b>Age</b>						
18-44	1.87 (1.76, 1.98)	<.0001	1.55 (1.33, 1.77)	<.0001	1.39 (1.27, 1.51)	<.0001
45-64	1.42 (1.38, 1.46)	<.0001	1.05 (0.98, 1.12)	0.1423	1.15 (1.09, 1.21)	<.0001
65-84	Ref.	-	Ref.	-	Ref.	-
85+	0.58 (0.54, 0.62)	<.0001	0.62 (0.58, 0.66)	<.0001	0.52 (0.48, 0.56)	<.0001
<b>Income</b>						
Q1	Ref.	-	Ref.	-	Ref.	-
Q2	0.97 (0.92, 1.02)	0.29	1.03 (0.97, 1.09)	0.225	1.08 (1.03, 1.13)	0.003
Q3	0.92 (0.87, 0.97)	0.0012	0.97 (0.91, 1.03)	0.2892	1 (0.95, 1.05)	0.868
Q4	0.92 (0.87, 0.97)	0.0012	0.95 (0.89, 1.01)	0.084	1.06 (1, 1.12)	0.0288
Q5	0.84 (0.79, 0.89)	<.0001	0.94 (0.88, 1)	0.0512	1.03 (0.97, 1.09)	0.2791
<b>Rurality</b>						
Urban	Ref.	-	Ref.	-	Ref.	-
Rural	1.14 (1.09, 1.19)	<.0001	1.01 (0.96, 1.06)	0.7187	0.98 (0.93, 1.03)	0.4083
<b># of Comorbidities</b>						
0	Ref.	-	Ref.	-	Ref.	-
1	3.58 (3.29, 3.87)	<.0001	2.29 (2.1, 2.48)	<.0001	1.76 (1.62, 1.9)	<.0001
2	4.27 (3.99, 4.55)	<.0001	3.18 (3, 3.36)	<.0001	2.42 (2.29, 2.55)	<.0001
3	4.87 (4.59, 5.15)	<.0001	4.58 (4.4, 4.76)	<.0001	2.94 (2.81, 3.07)	<.0001
4	5.02 (4.74, 5.3)	<.0001	5.98 (5.8, 6.16)	<.0001	3.45 (3.32, 3.58)	<.0001
5	5.43 (5.15, 5.71)	<.0001	7.87 (7.69, 8.05)	<.0001	4.27 (4.14, 4.4)	<.0001
6	6.09 (5.81, 6.37)	<.0001	12.05 (11.88, 12.22)	<.0001	5.31 (5.19, 5.43)	<.0001

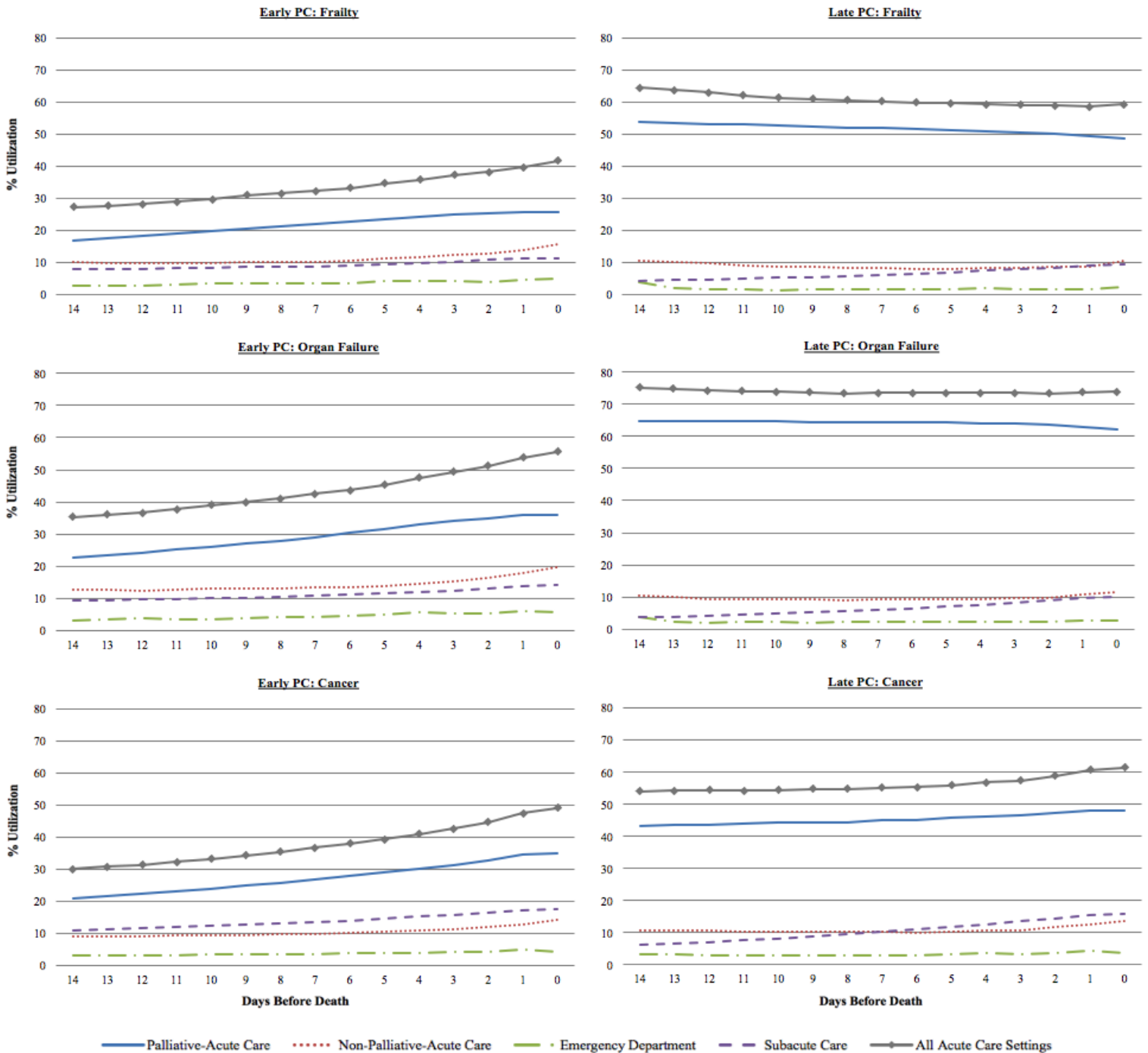
Ref: Never Used Acute Care Settings

Table 8: Multivariate logistic regression analysis: odds of spending >1 week in acute care settings (with exposure variable: palliative care initiation time by location)

<i>Exposure</i>	<i>Spent &gt;1 Week in Acute Care Settings; Among Users (Odds Ratio 95% CI)</i>					
	<i>Cancer</i>	<i>P-value</i>	<i>Frailty</i>	<i>P-value</i>	<i>Organ Failure</i>	<i>P-value</i>
<b>Palliative Care Initiation Time by Location</b>						
Early (Hospital)	1.47 (1.42, 1.52)	<.0001	2.62 (2.46, 2.78)	<.0001	2.3 (2.19, 2.41)	<.0001
Early (Out-of-Hospital)	Ref.	-	Ref.	-	Ref.	-
Late (Hospital)	3.55 (3.49, 3.61)	<.0001	8 (7.83, 8.17)	<.0001	10.3 (10.17, 10.43)	<.0001
Late (Out-of-Hospital)	0.87 (0.79, 0.95)	0.0005	0.99 (0.7, 1.28)	0.9203	0.99 (0.78, 1.2)	0.9461
Never	0.95 (0.88, 1.02)	0.0942	0.88 (0.74, 1.02)	0.0705	0.91 (0.81, 1.01)	0.0749
<b>Sex</b>						
Male	Ref.	-	Ref.	-	Ref.	-
Female	1.06 (1.02, 1.1)	0.0021	0.86 (0.8, 0.92)	<.0001	0.86 (0.81, 0.91)	<.0001
<b>Age</b>						
18-44	1.27 (1.15, 1.39)	0.0001	1.52 (1.18, 1.86)	0.0169	1.03 (0.88, 1.18)	0.6964
45-64	1.01 (0.96, 1.06)	0.7407	0.89 (0.79, 0.99)	0.0303	1.08 (1.01, 1.15)	0.0393
65-84	Ref.	-	Ref.	-	Ref.	-
85+	0.9 (0.84, 0.96)	0.0005	0.84 (0.78, 0.9)	<.0001	0.81 (0.76, 0.86)	<.0001
<b>Income</b>						
Q1	Ref.	-	Ref.	-	Ref.	-
Q2	1.01 (0.95, 1.07)	0.761	0.96 (0.88, 1.04)	0.3835	0.96 (0.89, 1.03)	0.205
Q3	1 (0.94, 1.06)	0.9649	0.95 (0.86, 1.04)	0.2412	0.93 (0.86, 1)	0.0442
Q4	0.96 (0.9, 1.02)	0.1645	0.99 (0.9, 1.08)	0.8762	0.97 (0.9, 1.04)	0.4559
Q5	0.97 (0.91, 1.03)	0.2773	0.92 (0.83, 1.01)	0.0547	0.89 (0.82, 0.96)	0.0021
<b>Rurality</b>						
Urban	Ref.	-	Ref.	-	Ref.	-
Rural	1.03 (0.97, 1.09)	0.2784	0.93 (0.85, 1.01)	0.0983	0.93 (0.87, 0.99)	0.0313
<b># of Comorbidities</b>						
0	Ref.	-	Ref.	-	Ref.	-
1	1.26 (0.79, 1.73)	0.3388	1.57 (1.18, 1.96)	0.0246	1.11 (0.89, 1.33)	0.3724
2	1.45 (0.98, 1.92)	0.1161	1.61 (1.24, 1.98)	0.0124	1.15 (0.94, 1.36)	0.1865
3	1.52 (1.05, 1.99)	0.0761	1.86 (1.5, 2.22)	0.0008	1.36 (1.15, 1.57)	0.0037
4	1.72 (1.25, 2.19)	0.0227	2.04 (1.68, 2.4)	0.0001	1.54 (1.33, 1.75)	<.0001
5	1.59 (1.12, 2.06)	0.0508	2.28 (1.92, 2.64)	<.0001	1.63 (1.42, 1.84)	<.0001
6	1.72 (1.25, 2.19)	0.022	2.57 (2.21, 2.93)	<.0001	1.82 (1.62, 2.02)	<.0001

Ref: Spent ≤ 1 Week in Acute Care Settings

Figure 1: Place of care utilization trajectories by disease cohort and palliative care initiation time



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## **CHAPTER 5: CONCLUSIONS**

This research found that significant variations exist in place of care in the last 2 weeks of life among cancer, frailty and organ failure decedents. Two weeks before death, only 29% of the population used acute hospitals, but this increased to 61% on the last day of life. Thus, this research proves that place of care in the last 2 weeks of life is an informative assessment outcome, which can inform policymakers more than just one's place of death – which is widely used in research measure end-of-life quality. Furthermore, clear disparities exist in place of care utilization as non-cancer populations make inappropriately high use of hospital care settings.

Additionally, this research demonstrated that palliative care timing plays a major role in service utilization at the end-of-life as well. In particular, late initiation of palliative care influenced organ failure and frailty decedents the most, as they were more likely to make use of acute care services, and more likely to spend a greater duration of time within such settings (compared to cancer decedents). This research adds support to the notion expressed in previous studies that non-cancer populations are largely disadvantaged in the realm of palliative care delivery.

In conclusion, this research displays that examining end-of-life healthcare service utilization at the population-level is feasible, useful, and more informative than place of death alone. Moreover, palliative care timing is an important factor that affects healthcare services used when near death. Future research should evaluate effective interventions for non-cancer patients near the end-of-life. This would help to ensure that quality of end-of-life and palliative care is not disproportionately favoring solely cancer patients. Finally, reducing acute care hospital use and

increasing community-based care is an important goal that should be at the forefront of policy changes across health systems.