Clinical paper

Prognosis of cardiac arrest in home care clients and nursing home residents: A population-level retrospective cohort study

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Abstract

Aim: To evaluate the prognosis of 30-day survival post-cardiac arrest among patients receiving home care and nursing home residents.

Methods: We conducted a population-level retrospective cohort study of community-dwelling adults (≥18 years) who received cardiac arrest care at a hospital in Ontario, Canada, between 2006 to 2018. We linked population-based health datasets using the Home Care Dataset to identify patients receiving home care and the Continuing Care Reporting System to identify nursing home residents. We included both out-of-hospital and in-hospital cardiac arrests. We determined unadjusted and adjusted associations using logistic regression after adjusting for age and sex. We converted relative measures to absolute risks.

Results: Our cohort contained 86,836 individuals. Most arrests (55.5 %) occurred out-of-hospital, with 9,316 patients enrolled in home care and 2,394 residing in a nursing home. When compared to those receiving no support services, the likelihood of survival to 30-days was lower for those receiving home care (RD = −6.5; 95 %CI = −7.5 to −5.5), with similar results found within sub-groups of out-of-hospital (RD = −6.7; 95 %CI = −7.6 to −5.7) and in-hospital arrests (RD = −8.7; 95 %CI = −10.6 to −7.3). The likelihood of 30-day survival was lower for nursing home residents (RD = −7.2; 95 %CI = −9.3 to −5.3) with similar results found within sub-groups of out-of-hospital (RD = −8.6; 95 %CI = −10.6 to −5.7) and in-hospital arrests (RD = −5.0; 95 %CI = −7.8 to −2.1).

Conclusion: Patients receiving home care and nursing home residents had worse overall prognoses of survival post-cardiac arrest compared to those receiving no pre-arrest support, highlighting two medically-complex groups likely to benefit from advance care planning.

Keywords: Home care, Nursing home, Cardiac arrest, Prognosis, Survival

Introduction

Despite recent advancements in cardiac arrest management, the one-year survival rate is 13 % for arrests that occur in hospital and 8 % for out-of-hospital.1–3 The minority who survive commonly report post-arrest physical disabilities, cognitive impairment, mental illness, and a decreased quality of life.3–5 Post-cardiac arrest outcomes are worse among older adults and those with frailty.5–7

Patients receiving home care and nursing home residents are two older, medically-complex populations with high rates of frailty and emergency service use.5–10 Approximately 30 % of older adults in Canada receive publicly funded home care or reside in a nursing...
Home care is a term that encompasses a wide array of personal and clinical support services, such as personal support, nursing care, physical or occupational therapy, and mental health care. When medical complexity or service needs extend beyond what is available in the home care setting, individuals and families often turn to nursing homes, which provide 24-hour support and residence. In Canada, it is estimated that 20% of individuals residing in long-term care institutions could be managed in the home care setting, given their similar support needs and clinical profiles.

The high rates of cardiorespiratory illness and advanced disease in these populations increase their risk for cardiac arrest, suggesting proactive decision-making about end-of-life is of great importance upon service enrollment. Research comparing post-cardiac arrest survival between nursing home residents and community-dwelling older adults has been inconsistent. Little is known about the rates of survival post-cardiac arrest in patients receiving home care, an expanding population with unmet care needs in the community. Fundamental prognosis studies are essential to assess the relative burden of disease and target individuals most likely to benefit from advance care planning.

Our objective for this study was to evaluate the likelihood of survival to 30-days post-cardiac arrest among patients receiving home care and nursing home residents compared to community-dwelling individuals not enrolled in community support services. We hypothesized that home care and nursing home populations would have worse prognoses of 30-day survival post-cardiac arrest. Our secondary objective was to evaluate survival to one-year and in-home death. We provide absolute risk estimates for both in-hospital and out-of-hospital cardiac arrest.

**Methods**

**Study design and data sources**

We conducted a population-level retrospective cohort study linking multiple de-identified administrative health datasets housed within ICES, formerly known as the Institute of Clinical and Evaluative Sciences. We extracted data on all patients who received cardiac arrest care from any hospital in Ontario between January 1, 2006, and December 31, 2016. We classified patients as in-hospital cardiac arrest if the arrest occurred following a hospital admission or out-of-hospital cardiac arrest if the arrest or management occurred in the pre-hospital or ED setting. While the ED is physically located within the hospital system, most cardiac arrests managed in the ED occur in the pre-hospital setting and are commonly classified as out-of-hospital arrests.

The Home Care Dataset and Continuing Care Reporting System were used to identify patients receiving long-stay home care services (>60 days) and nursing home residents. We extracted patient demographics (e.g., age and sex) from the Registered Person Data Base. We collected data on relevant diagnoses, visit characteristics, clinical interventions, and emergency department disposition for out-of-hospital arrests from the National Ambulatory Care Reporting System dataset. For in-hospital arrests, we collected this data from the Discharge Abstract Database. We used the Assistive Devices Program dataset to identify individuals who were approved for supportive functional (e.g., wheelchair, cane, scooter) or sensory (e.g., hearing aids, communication devices) health devices. We used the Ontario Myocardial Infarction Dataset to identify individuals who received pre-arrest hospital care in Ontario for myocardial infarction.

We used the Vital Statistics and Death database to identify the completion of an autopsy and the etiology, location, and timing of death. The databases used in our study are routinely checked for quality and have been validated for use to conduct population-level health research in Ontario and Canada.

A waiver of ethics review was approved by the Hamilton Integrated Research Ethics Board, as informed consent is not required to leverage this data in accordance with Section 45 of Ontario’s Personal Health Information Protection Act. We reported our findings in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

**Cohort and exposures**

We extracted data on all patients aged 18 and older who received hospital care (ED or in-patient) at any hospital in Ontario for cardiac arrest. We used a follow-up window of one-year post-cardiac arrest. For individuals who had an in-hospital cardiac arrest, we included only those arrested within 72 hours of ED registration. We elected to use the ED registration time as the reference point for time-based measures, as it signals the first interaction with the hospital system. Given our interest in pre-arrest support needs, a 72-hour time frame was chosen to mitigate the risk of unknown confounders and health decline that arises throughout the hospital stay. Prior work has demonstrated that in-hospital arrests are most likely to occur within two days of hospital admission. Thus, we allowed a 24-hour buffer period for patients admitted and boarded in the ED while awaiting transfer to an in-patient unit.

We used a validated series of Canadian Classification of Health Interventions codes to identify those who received cardiopulmonary resuscitation (IH30JN, IH30OJY) and International Statistical Classification of Disease and Related Health Problems (ICD-10) codes to identify incidents of cardiac arrest (I46.1, I46.2, I46.8, I49.0, I49.01, I49.02, R96.0, R96.1, R98, R99). In the rare case where two arrests occurred within the study period, we used the first event only, given the worse odds of survival following re-arrest and to mitigate the risk of correlated observations. We excluded patients who were not residents of Ontario and those without a valid Ontario Health Insurance Plan number or birth date. We excluded patients who received a surgical intervention prior to their arrest within the 72-hour observation window to best capture arrests exacerbated by medical conditions rather than surgical or traumatic causes, which are less common, and require different clinical interventions.

We measured age as a categorical variable due to data privacy limitations within ICES, with years of age collapsed to 18–49, 50–64, 65–74, 75–84, and 85 + years. Triage acuity was assessed following ED registration using the Canadian Triage Acuity Scale, a five-item ordinal scale used in hospitals across Canada with a score of one indicating the highest medical acuity. We used ICD-10 codes to determine pre-arrest morbidity status.

**Outcomes**

Our primary outcome for this study was survival to 30-days post-cardiac arrest. We elected to use this time frame, knowing it closely approximates survival to hospital discharge and based on recommendations from the Utstein guidelines. We also examined survival to one year and the likelihood of in-home death.

In-home death was defined as any death that did not occur within a health institution (e.g., hospital, rehabilitation center, nursing home, etc.). Both survival and location of death are known to be patient-
important outcomes and key priorities for cardiac arrest research per the Core Outcome Set for Cardiac Arrest (COSCA) initiative and the International Consortium for Health Outcome Measurement (ICHOM) – Older Person Working Group.38–39

Analysis
For descriptive statistics, we report measures of frequency and central tendency. Odds ratios and 95% confidence intervals (CIs) were calculated using logistic regression and converted to absolute risks as recommended by the Prognosis Research Strategy (PROGRESS) group and the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) prognosis working group.22,40 For multivariable models, we adjusted for age and sex, mindful that these are two prognostic factors known to influence health trajectories, post-cardiac arrest outcomes, and bystander response for out-of-hospital arrests.41–42 We did not include nursing home residents in the analysis of death location, as we could not delineate the specific type of institution where an individual died (e.g., nursing home versus hospital) using our data. We evaluated prognoses in the overall cohort and within sub-groups of out-of-hospital and in-hospital cardiac arrest. Missing data was scant (<0.1%) and deleted within each analysis, given the descriptive nature of this study. Data were managed and analyzed in R version 3.6.0.

Results
Our cohort contained 86,836 individuals who experienced cardiac arrest either out-of-hospital or in-hospital. Most arrests occurred in-hospital (n = 47,226; 55.5%) and of the 39,610 (45.5) who arrested out-of-hospital, 7,207 (18.1%) were dead upon hospital arrival despite pre-hospital cardiopulmonary resuscitation. Most in the cohort were not enrolled in pre-arrest support services (85.9%), were male (60.3%), transferred by ambulance (83.3%), and presented to the hospital during daytime hours (60.2%). Fig. 1 displays a flow diagram of patient inclusion and survival. Pre-arrest frequencies, proportions, and relative risk estimates across pre-arrest support status, age strata, and arrest setting can be found in Supplemental Tables 1–3.

Pre-arrest characteristics associated with enrollment in support services
Table 1 displays the pre-arrest patient features, stratified between those receiving home care, residing in a nursing home, and those not enrolled in support services. Fig. 2 displays a forest plot of patient characteristics associated with the absolute risk of needing home care or nursing home residence. A positive association was found between age and enrollment in home care or nursing home residence, with those 85 years and older in greatest need (RD = 38.7;
Table 2 compares pre-arrest patient features between out-of-hospital and in-hospital cardiac arrest. We found the oldest cohort (85+) had the greatest chances of out-of-hospital arrest compared to those under 50 years (RD = 7.5 – 7.6; 95 % CI = 6.7 – 8.3) and in-hospital setting (RD = 9.3 – 9.5) and to arrest during the daytime between 0700 to 1900 hours (RD = 21.3; 95 % CI = 21.3 – 22.5).

Pre-arrest features between arrest settings
Table 2 compares pre-arrest patient features between out-of-hospital and in-hospital cardiac arrest. We found the oldest cohort (85+) had the greatest chances of out-of-hospital arrest compared to those under 50 years (RD = 7.5 – 7.6; 95 % CI = 6.7 – 8.3) and in-hospital setting (RD = 9.3 – 9.5) and to arrest during the daytime between 0700 to 1900 hours (RD = 21.3; 95 % CI = 21.3 – 22.5).

Post-Cardiac arrest survival
Adjusted odds ratios and confidence intervals can be found in Supplemental Tables 4–6 for the overall, out-of-hospital, and in-hospital cohorts.

30-Day Survival. Overall, 31,180 (36.0 %) survived to 30-days post-cardiac arrest. Most patients died after one-week post-cardiac arrest (61.9 %). After adjusting for age and sex, patients receiving home care (RD = −6.5; 95 % CI = −7.5 − −5.0) and nursing home residents (RD = −7.2; 95 % CI = −9.3 − −5.3) had worse prognoses of survival to 30-days compared to those receiving no support services. Patients receiving home care services had worse prognosis of 30-day survival in both the out-of-hospital setting (RD = −6.7; 95 % CI = −7.6 − −5.7) and in-hospital setting (RD = −8.7; 95 % CI = −10.6 − −7.3). Nursing home residents had similar results in the out-of-hospital (RD = −8.6; 95 % CI = −10.6 − −5.7) and in-
hospital settings (RD = −5.0; 95 %CI = −7.8 − −2.1). Fig. 3 displays the probability of survival to one month between home care clients, nursing home residents, and those receiving neither service. Fig. 4 displays a forest plot of absolute risk differences between pre-arrest support needs and survival (30–days and one–year) post-cardiac arrest, after adjusting for age and sex.

**One-Year Survival.** Approximately three in ten (31.6 %) survived to one-year post-cardiac arrest. After adjusting for age and sex, those receiving home care (RD = −9.6; 95 %CI = −10.5 − −8.5) and those residing in a nursing home (RD = −11.8; 95 %CI = −13.6 − −9.7) has worse prognoses of one-year survival post-cardiac arrest compared to those receiving no pre-arrest supports. Patients receiving home care had a worse prognosis of one-year survival in both the out-of-hospital (RD = −7.7; 95 %CI = −8.6 − −6.9) and in-hospital setting (RD = −13.2; 95 %CI = −14.8 − −11.5), compared to those receiving no pre-arrest support. Similarly, nursing home residents had a worse absolute risk of survival in the out-of-hospital (RD = −8.7; 95 %CI = −9.9 − −7.4) and in-hospital settings (RD = −12.8; 95 %CI = −16.1 − −10.2).

**In-Home Death.** After excluding nursing home residents, only 4,586 (7.8 %) of deaths occurred in the home setting. Patients receiving home care services were less likely to die at home within a year of cardiac arrest in the out-of-hospital cohort only (RD = −1.3; 95 %CI = −2.2 − −0.05). Age had a negative and graduated relationship with home death, whereby the likelihood of home death decreased more with each increase in age strata. Pre-hospital death was similar between those who died in-home (13.9 %) and those who did not (12.1 %).

**Discussion**

We determined that patients who require home care or nursing home residence are less likely to survive to 30-days post-cardiac arrest than those not receiving pre-arrest support services. The absolute risk differences were similar between patients receiving home care and nursing home residents, overall, and within subgroups of out-of-hospital and in-hospital cardiac arrests. We demonstrated that younger people have better survival outcomes and are more likely to die at home, and patients receiving home care were more likely to die in their homes if arrests occurred out-of-hospital.

**Comparison to Prior studies**

Little is known about the prognosis of cardiac arrest in the home care population. However, our study parallels the prior work showing nursing home residents have worse survival outcomes than older adults living at home. Our study provides a novel population-level comparison of survival across the three cohorts in
Ontario, Canada: home care clients, nursing home residents, and community-dwelling residents receiving no pre-arrest support services. Our study confirms that age is a pre-arrest prognostic factor inversely associated with survival outcomes for out-of-hospital and in-hospital arrests.7,43

Clinical and policy implications

Home care clients and nursing home residents were less likely to survive to 30-days and one-year post-cardiac arrest. Patients receiving home care clients were more likely to die at home if they arrested in the out-of-hospital setting. These two patient-important outcomes should be discussed during advance care planning in home care and nursing home populations.39 These populations are at greater risk for cardiac arrest, given their advanced age and greater prevalence of late-stage chronic disease. Foreknowledge about pre-arrest support status is readily available in most clinical settings; this prognostic factor should be considered during shared decision-making about preferences for end-of-life care and directives.

We demonstrated that identifying enrollment in pre-arrest support services was associated with 30-day and one-year survival with similar absolute risks between home care and nursing home populations (<3% difference). The similar prognoses of these populations could signal a significant overlap in the rates of frailty and medical complexity found among them. The longstanding lack of long-term care beds has a downstream effect on the home care population, resulting in greater health decline at home and upon admission to long-term care. Nursing home residents were older, though home care clients were more likely to arrest with a high-risk chronic conditions such as congestive heart failure and chronic obstructive pulmonary disease. Arrests could theoretically have occurred in the least frail of nursing home residents and the frailest of the home care population. Another possibility is nursing home residents are more likely to experience a witnessed arrest and receive cardiopulmonary resuscitation, given their access to 24-hour nursing and support care.17–18

Overly optimistic public perceptions and media portrayals highlight a disconnect in public health communication and the importance

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**Table 2 – Comparison of Pre-Arrest Features Between 39,610 (45.5%) Out-of-Hospital Arrests and 47,226 (55.5%) In-Hospital Arrests in Ontario, Canada.**

| Variable                                      | Out-of-Hospital | In-Hospital |
|-----------------------------------------------|-----------------|-------------|
| **Age (Years)**                               |                 |             |
| 85 +                                          | 6,131 (15.5)    | 5,326 (11.3)|
| 75 – 84                                       | 9,078 (22.9)    | 10,277 (21.8)|
| 65 – 74                                       | 8,331 (21.0)    | 9,574 (20.3)|
| 50 – 64                                       | 10,020 (25.3)   | 11,540 (24.4)|
| 18 – 49                                       | 6,050 (15.3)    | 10,509 (22.3)|
| **Sex (Female)**                              |                 |             |
| 13,662 (34.5)                                 | 20,804 (44.1)   |             |
| **Mode of Arrival (Walk-In)**                 | 3,618 (9.1)     | 10,895 (23.1)|
| **Triage Acuity (CTAS)**                      |                |             |
| I                                             | 32,936 (83.4)   | 18,059 (38.3)|
| II                                            | 4,355 (11)      | 19,037 (40.4)|
| III                                           | 1,640 (4.1)     | 8,849 (18.7)|
| IV                                            | 186 (0.4)       | 1,044 (2.2)|
| V (Least Urgent)                              | 357 (0.9)       | 149 (0.3)|
| **Diagnoses**                                 |                 |             |
| Congestive Heart Failure                       | 11,703 (29.5)   | 16,418 (34.8)|
| COPD                                          | 12,297 (31)     | 20,253 (42.9)|
| Dementia                                      | 4,225 (10.7)    | 6,569 (13.9)|
| Diabetes                                      | 14,105 (35.6)   | 18,113 (38.4)|
| Hypertension                                  | 26,825 (67.7)   | 32,182 (68.1)|
| **Prior Myocardial Infarction**               | 6,011 (15.2)    | 3,496 (7.4)|
| **Pre-Arrest Support Services**               |                 |             |
| Homecare                                      | 4,076 (10.3)    | 5,240 (11.1)|
| Nursing Home                                  | 1,474 (3.7)     | 1,460 (3.1)|
| None                                          | 34,060 (86.0)   | 40,526 (85.8)|
| **Approved for Health Device**               |                 |             |
| Locomotion                                    | 1,890 (4.8)     | 2,463 (5.2)|
| Sensory & Communication                       | 806 (2.0)       | 947 (2.0)|
| **Autopsy Completed**                        | 997 (2.9)       | 524 (2.1)|
| **Underlying Cause of Death**                 |                 |             |
| Atherosclerotic Heart Disease                 | 6,434 (18.4)    | 1,312 (5.4)|
| Myocardial Infarction                         | 5,698 (16.5)    | 1,684 (6.9)|
| COPD Exacerbation                             | 566 (1.6)       | 989 (4.1)|
| Pneumonia                                     | 401 (1.2)       | 1,167 (4.8)|
| Diabetes                                      | 1126 (3.3)      | 302 (1.3)|

COPD = Chronic Obstructive Pulmonary Disease; CTAS = Canadian Triage Acuity Scale
of clinician-driven pragmatic discussions about end-of-life care.\textsuperscript{44–45} End-of-life care planning is commonly postponed until critical illness,\textsuperscript{46} resulting in uninformed or surrogate decision-making and end-of-life care that is not congruent with patient preferences (i.e., overtreatment).\textsuperscript{47} Proactive and shared-decision making about advance care directives have the potential to realign patient knowledge, values, and preferences with realistic expectations.\textsuperscript{48–49} Home care clients and nursing home residents are ideally set up for informed and shared decision-making about end-of-life wishes upon service enrollment, given the provision of detailed and routine assessments within these populations. These pragmatic discussions become more important as home care clients and nursing home residents age. Older patients are less likely to die at home and are more likely to die in a hospital, which could contrast with their care preferences or directives.\textsuperscript{39,50}

**Strengths and limitations**

Our study is novel in providing a population-level evaluation of survival post-cardiac arrest and the probability of in-home death according to pre-arrest support needs (e.g., home care and long-term care), age group and sex. Population-level data is ideal for evaluating the prognosis of those who experience cardiac arrest, as it can best capture the low incidence rates of cardiac arrests to inform policymaking at a regional or national level.\textsuperscript{51}

For in-hospital arrests, we could not provide a true measure of overall prognosis, as data were not originally extracted on all in-hospital arrests that occurred, but rather those that occurred within a 72-hour window, for previously mentioned reasons. This limitation could explain our high survival rates for in-hospital arrests, as patients are at greater risk for medical decompensation the longer the hospital length of stay.\textsuperscript{52} Another plausible reason for our high survival rate is that patients enrolled in home care or nursing home residence are more likely to have a do-not-resuscitate directive and are likely healthier than residents with these advanced orders.\textsuperscript{53}

For out-of-hospital arrests, we likely missed a small proportion of those who received resuscitation in the community but were not transferred to hospital.

Using ICD-10 codes in administrative records to identify co-morbidities is a limitation when trying to understand diagnoses in this population, given the inherent degree of coding errors and accuracy of information transcription.\textsuperscript{54} We were unable to delineate if institutional death occurred in a nursing home or hospital, so we were forced to exclude nursing home residents from this analysis. Due to cell size limitations, we could not examine age as a continuous...
variable. We were thus forced to categorize the variable, though we used as many cut-offs as possible to promote the precision of statistical estimates. Finally, we lacked population-level data on multimorbidity and frailty, two unique prognostic factors that would have added richness to this analysis.

Conclusion

We found that home care clients and nursing home residents had worse prognoses of 30-day and one-year survival post-cardiac arrest. We also demonstrated that older adults were less likely to die at home post-cardiac arrest. Our findings emphasize the need for proactive discussions about end-of-life care during admission and follow-up assessments in the home care and nursing home populations.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2022.100328.
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