SHORT REPORTS

Progress towards predicting 1-year mortality in older people living in residential long-term care

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Abstract

Background: frail older people living in residential long-term care (LTC) have limited life expectancy. Identifying those with poor prognosis may improve management and facilitate transition to a palliative approach to care.

Objective: to develop methods for predicting mortality in LTC.

Design: a population-based cohort study.

Setting: LTC facilities, Auckland, New Zealand.


Methods: mortality data were obtained from New Zealand Ministry of Health. Two methods for assessing mortality risk were developed using demographic, functional and health service information: (i) two geriatricians blinded to identifying data and to mortality, independently reviewed survey, medications and pre-survey hospitalisations data, and grouped residents according to perceived risk of death within 12 months; (ii) multivariate logistic regression model used the same survey and medication items as the geriatricians.

Results: for the geriatricians’ assessment, each quintile of perceived risk was associated with a significant increase in mortality ($P < 0.001$). Area under the curve (AUC) for both physicians was 0.64. The logistic regression model included age, gender, assistance with feeding and requiring night attention, all variables which are easily available from LTC records. AUC for the model was 0.70, but when validated against the entire OPAL cohort, it was 0.65. When either or both geriatrician and the model together predicted high risk of death, 1-year mortality was >50%.

Conclusion: two methods with the potential to identify older people with limited prognosis are described. Use of these methods allowed identification of over half of those who died within 12 months.

Keywords: long-term care, predictive modelling, end of life care, older people

Introduction

The long-term care (LTC) population in New Zealand (NZ) is projected to grow rapidly over coming years. Currently, over half of those aged 85 and older will die in LTC. Clinicians have increasing choices about management, and decisions must take account of prognosis, risks versus benefits of treatment, patients’ views regarding care goals and balance the need for curative and palliative care interventions.

A number of approaches to predict mortality have been proposed (see Supplementary data, Appendix 1 available in Age and Ageing online). The UK-based Gold Standards Framework (GSF) [1, 2] proposes a ‘trigger’ question ‘would you be surprised if this person died within the next months, weeks or days?’ and appropriate clinical markers. Others have developed and reviewed predictive models [3–6], many based on the Minimum Data Set (MDS) [7–10]. However, these models often use complicated formulae and may not
be clinically pragmatic. In this study, we explored two methods of predicting mortality in a 2008 LTC cohort in Auckland, NZ. We utilise a brief geriatricians’ clinical assessment and statistical model employing readily available data from LTC records.

**Methods**

**Data collection**

Our study population was drawn from the Older Persons’ Ability Level (OPAL) study, a 2008 census-type survey of LTC residents across all certified facilities in Auckland [11, 12]. Response rate was 89%. For each resident, facility staff completed a demographic, functional and health characteristics questionnaire.

Resident hospital discharge diagnoses (12 months pre-OPAL), subsidised medications (3 months pre-OPAL) and level of care were linked to 12-month mortality data from NZ Ministry of Health (MoH) databases. NZ LTC care levels include low-level ‘Rest-home’ care, higher level ‘Private hospital’ care requiring 24-h registered nurse availability, secure ‘Dementia’ care to address safety issues, e.g. wandering and ‘Psychogeriatric’ care for those with psychological and behavioural dementia issues or psychiatric illness and physical frailty. A random sample of 500 LTC residents from OPAL was selected from the 6,289 residents with mortality information. In selecting the sample, different sampling fractions for four care levels were used to optimise power.

**Geriatrician assessment**

Two geriatricians were independently provided with anonymous resident details (n = 500), including age, gender, facility type, mobility, self-care, continence, behaviour, communication, cognition, awareness, feeding, need for night care, medication use and discharge diagnoses of hospital admissions. Geriatricians were blinded to resident identities, mortality and each other’s ratings. They did not see residents, view medical records or become involved in clinical care. Based on these data, geriatricians ranked residents according to perceived 12-month mortality risk into one of five categories (0–20% risk, 20–40%, etc.). This ranking was a ‘global impression’ from all available data, and specific risk factors were not identified.

**Descriptive analyses**

Kaplan–Meier methods were used to plot survival curves for each assessor and to test difference between them. Ratings were divided into high and low risk with a threshold of 40% predicted mortality. Analyses were weighted to adjust for differential sampling fractions.

**Logistic regression modelling**

Multivariate logistic regression analyses were used to predict 12-month mortality, without reference to geriatricians’ assessments. The 500 individual records were weighted to fairly represent the proportions at each care level. All independent variables (n = 55) from OPAL and medications data provided to the geriatricians were converted to binary form and made available to the model, then progressively dropped using backwards elimination.

**Receiver operating curves**

We plotted the receiver operating curves (ROC plots) and calculated areas under the curves (AUCs) of the two assessors and the model.

We used AUC to test the generalisability of the model to the full OPAL cohort with linkage data.

Ethics approval was granted by Northern × Regional Ethics Committee (ref: NTX/11/EXP/193).

**Results**

**Descriptive**

The stratified random sample of 500 residents included 180 in rest-home level care, 149 in private hospital level care, 106 in secure dementia care and 65 in psychogeriatrics care. Mean age was 83 years. Death within 12 months of OPAL was recorded for 13% of those in rest-home care, 26% in dementia care, 28% in psychogeriatrics care and 34% in private hospital care.

**Geriatricians’ assessments**

For each increase in geriatrician-assigned level of risk, there was significantly increased mortality, P < 0.001, illustrated by Kaplan–Meier survival curves shown in Figure 1.

**Logistic regression model**

The logistic regression models identified four variables that together predicted death by 12 months (adjusting for care level): age, gender, needing help with feeding and needing attention twice or more per night. For each additional year of age, risk of death increased by 4% [95% confidence interval (CI) 0.8–7.4%, P = 0.014]. Men had higher risk of death [relative risk (RR) 2.10, CI 1.22–3.60, P = 0.007]. Those needing help to feed or attention twice or more per night had greater risk (RR = 3.07, CI 1.69–5.59, P = 0.002; RR = 2.51, CI 1.50–4.20, P = 0.001, respectively).

**Combined model**

Table 1 shows the combination of the two methods using 40% risk as the split point. It shows that if either one or both geriatrician classified as >40% mortality risk, combined also with the model predicting >40% mortality risk, 55–56% died within 12 months. In contrast if both geriatricians and model predicted mortality risk under 40%, the mortality rate was just 4.3%.
ROC curves
Areas under the two ROC geriatricians’ curves (AUC) were very similar, 0.64 for each geriatrician. The AUC for the model was 0.70.

The regression model was then validated using all 6,289 people from OPAL who were matched with MoH information. The AUC for the model was 0.65.

Discussion
Predicting mortality is an important but controversial issue [13]. In modern healthcare systems, care options include screening investigations, medications for both symptomatic and prognostic benefit, and palliative approaches: often difficult choices must be made. Older people in LTC are a frail group for whom these choices are particularly difficult.

Figure 1. Survival to 12 months, grouped by two physicians according to perceived risk of death.
Table 1. Death by 12 months from OPAL according to geriatrician’s assessment and model scores, using a cut point of 40 (of 100)

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<td>416</td>
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Addressing end-of-life care is important in provision of quality LTC [14]. An essential step to adopting palliative approaches is to reliably recognize people likely to be in the final stages of their life.

In the current study, analysis of the brief geriatricians’ assessments showed that as perceived risk increased, actual mortality significantly increased, although geriatricians did overestimate probability of death, as reported previously in heart failure [15]. This approach is similar to UK GSF guidelines [2] which suggest use of the question ‘Would you be surprised if this person died within months, weeks or days?’ with markers of frailty like weight loss, declining function or exhaustion. However, Scottish general practitioners reported that the ‘surprise’ question was not useful [16]. Conversely, in acute care, this approach had good sensitivity, specificity and predictive values (O’Callaghan et al. 2013, under review). However, in our study, markers of frailty were not available.

Our second approach was logistic regression modelling using the same demographic, functional and health items available to the geriatrician assessors. We found just four variables reasonably accurately predicted 12-month mortality (AUC = 0.70). Other than age and gender only two other variables were predictive: needing help with eating and needing attention twice or more per night; these are both routinely collected by LTC staff and hence are both readily available. No diagnostic, laboratory or clinical indicators were included.

Combining a geriatrician’s assessment with our model, we found that when both geriatricians and model predicted high risk, >50% died within 1 year. When both methods predicted low risk, mortality was only 4.3%. This combination of methods allows identification of low- and high-risk groups where the high-risk group may benefit from further assessment.

There have been previous studies examining prediction of mortality in LTC (Supplementary data, Table available in Age and Ageing online). In a validation cohort of a number of models, Kruse et al. [17] found that Flacker–Kiely’s revised model [10] had the best discrimination for 12-month mortality, AUC = 0.71. This model was developed in US nursing homes, and its application may be limited in other settings.

Previous models included age [3, 7, 10, 18], gender [3, 7, 10, 18], nutritional problems [7, 10, 18], functional decline [5, 7, 10] and reduced cognition/dementia [3, 7, 18]. Many included co-morbid diagnoses, particularly cardiac failure [7, 10, 18], renal failure [7, 10, 18] and advanced respiratory disease [7, 10, 18] not available to our model. Of those reporting AUC, all were around 0.70—similar to ours. This moderate predictive value would limit the use of current models, including ours, in clinical practice but has potential for further development. Our model uses data easily available from LTC records including all care levels, updatable as the clinical situation changes. Our model is simpler to use than previous models that require a large number of variables.

Communicating with people about prognosis and care may allow people to plan and come to terms with their prognosis and avoid acute crises, unnecessary treatments and hospital admissions [19] and guide a transition to a palliative approach to care. Over 80% of the population (all ages) stated they would wish to be told if they had a terminal illness and expected doctors to initiate conversations [20]. However, doctors report difficulties in discussing prognosis with patients [16, 20], in part due to difficulty of predicting outcomes in frail older people. This study suggests that improved prognostication for frail older people in LTC is possible and may be improved in conjunction with geriatrics assessments.

Key points
- As geriatricians’ assessment of risk increases, so does probability of mortality.
- A simple logistic regression model using readily available data from LTC has moderate predictive value for 1-year mortality.
- A combination of geriatricians’ assessment and model identified over half of people who died within 12 months.

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Conflicts of interest
None declared.

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Supplementary data
Supplementary data mentioned in the text are available to subscribers in Age and Ageing online.
References


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