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Age and outcome in acute emergency medical admissions

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Abstract

Background: there is a lack of outcome information with respect to older health service users. The purpose of this study was to examine 30-day in-hospital mortality and its predictors in all elderly patients admitted as a medical emergency to our hospital.
Methods: all patients admitted between 2002 and 2008 were studied, linking anonymised clinical, administrative, laboratory and mortality data. Significant univariate predictors of outcome, including co-morbidity and illness severity score, were entered into a multivariate logistic regression model, adjusting the univariate estimates of the effect of age on in-hospital mortality.
Results: we admitted 23,114 consecutive acute medical admissions between 2002 and 2008; 30-day in-hospital mortality was 20.7% in the over 75 age category versus 4.5% in those younger. The unadjusted OR for a 30-day in-hospital mortality in the over 75 category of 5.21 (95% CI 4.73, 5.73) fell to 4.69 (95% CI 4.04, 5.44) when adjusted for outcome predictors excluding acute illness severity and 2.93 (95% CI 2.50, 3.42) when acute illness severity was added as a covariate. When the interaction between age and co-morbidity is examined, the odds ratio adjusts to 3.22 (95% CI 2.63, 3.6).
Conclusion: acute illness severity is more important than co-morbidity in explaining the outcome in older patients admitted as medical emergencies. Service planning for acute elderly care should be based on effective disease management programmes but recognise the contribution of acute illness severity to outcome when conditions deteriorate.

Keywords: *in-hospital mortality, acute illness severity, age, elderly*

Introduction

Sixteen percent (82 million people) of the European Union's population are over the age of 65 years. Twenty-four percent of whom are over the age of 80 years. Trends indicate that the over 65-year age group will increase by 21%, by the year 2020 (18.4 million in real terms), whereas the rate of increase in the over 80 group, the 'old–old', will be faster at 34% representing an absolute increase of 7.5 million in this age category alone [1]. Health planners have recognised that the ageing profile of Europe's population poses problems for the acute health sector as well as challenges in relation to public health policy and planning [2–4]. The discussion is predominantly framed in economic terms.

The perspective of front-line clinicians must be pragmatic and focus on delivery of optimal health outcomes while remaining mindful of costs. There is an emerging literature on systems of care delivery and how re-orientation can impact on process and outcomes [5–9]. In parallel, there has been discussion around how to optimally cater for older people within the acute sector [9–11]. A Royal College of Physicians report [12] describes four models of care: (i) age defined—patients are admitted to medical or elderly wards on the basis of age, (ii) needs related (or traditional)—age alone is not the criteria for admission, (iii) a common admissions model—patients are admitted to an all-age ward, then decanted along appropriate age and disease specific lines and (iv) the fully integrated model—patients are admitted to integrated wards staffed by a variety of physicians including geriatritians. In common with the majority of mechanisms of 'all-comer' acute medical care, there is a paucity of data to describe how each of the models described above perform in the delivery of care to the acutely ill elderly medical patient.

The lack of quality outcome data in elderly people led to a European initiative, an admissions case-mix system for the Elderly (ACME), to generate data on acute elderly care [13, 14]. With respect to acute medical admissions to a large Irish teaching hospital, our group have described how the implementation of a process of care, an acute medical admissions unit, delivered a 50% reduction in mortality over a 6-year period [8]. Further, the application of process has been mapped and compared between the individual consultants operating the system [15, 16] and cost parameters have been tracked [17].

Where demographic change is impacting on economic planning, and with the emergence of Health Informatics as a powerful tool, professional decisions on systems of care must be based on hard outcomes such as mortality rather than speculations regarding adequacy of care. The purpose of this study was to describe the in-hospital mortality outcome data across all acute medical admissions for the period 2002–08 with a focus on the effect of age, co-morbidity burden and acute illness severity.

Methods

Background

St James's Hospital (SJH) operates a daily sectorised acute general medical 'take-in' serving as a secondary care centre for emergency medical admissions for its local Dublin catchment area. In 2003, two of the modern centrally located medical wards were re-configured to function as an AMAU—a medical receiving unit where all acutely ill medical patients were admitted from the ED to a single location. The 59-bed AMAU capacity was such that up to 70% of all admissions would be predicted to receive their entire hospital care within the unit (maximum permitted stay in AMAU: 5 days). The operation and outcome of the AMAU to 2007 have been described [8].

Data collection

A patient database linked the computerised patient administration system (PAS) to the hospital in-patient enquiry (HIPE) scheme. HIPE is a national database of coded discharge summaries from acute public hospitals in Ireland. Ireland has used the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) for both diagnosis and procedure coding from 1990 to 2005 and ICD-10-CM thereafter. Linking the HIPE data set with the PAS data set permits the application of routinely collected data for the purposes of research, planning and quality control. Data collected include hospital number, admission and discharge dates, date of birth, gender, area of residence by county, principal diagnosis, up to nine additional secondary diagnoses, procedures (principal and up to nine additional secondary procedures) and admitting consultant. Additional information uploaded to the database included physiological, haematological and biochemical data sets relating to the admission. The HIPE data set, anonymised and aggregated, of all coded diseases at the time of discharge/death, together with procedures and investigations undertaken during the hospital stay was provided to and examined by us. Data were related to all emergency medical patients admitted to SJH between 1 January 2002 and 31 December 2008.

Derangement of haemodynamic and physiological admission parameters may be utilised to predict clinical outcome [18]. We derived and applied an acute illness severity score, predicting in-hospital mortality from the following nine parameters recorded in the Emergency Department: age, respiratory rate, oxygen saturation and routine laboratory tests [i.e. serum sodium (Na), serum potassium (K), serum urea, serum albumin, red cell distribution width and white blood cell count]. A weighted score, based on the relationship between each parameter and outcome was derived; for the model, we utilised the 2002–06 data set for derivation and the 2007–08 data for validation. The area under the curve (AUROC) to predict an in-hospital death at 5 days was 0.94 in the derivation ($n = 5334$) and 0.90 ($n = 2784$) in the validation data set and at 30 days 0.88 ($n = 10763$) and 0.86 ($n = 6213$) respectively.

Statistical methods

Descriptive statistics were calculated for background demographic data, including means/standard deviations (SDs), medians/interquartile ranges (IQRs) or percentages. The age–frequency distribution was examined and quantiles derived, based on the 10, 25, 75 and 90 centiles of the distribution [19]. Comparisons between categorical variables and mortality were made using chi-square tests. Logistic regression analysis was used to examine the association between age and 30-day hospital mortality, adjusting for gender, major disease by category

(MDC), Charlson co-morbidity index, an ICU admission, a re-admission, any troponin elevation, a blood transfusion, quarter of year, log length of stay and acute illness severity score (without age). Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated where appropriate. Statistical significance at $P < 0.05$ was assumed throughout. JMP v.7 statistical software (SAS Institute Inc.) was used for analysis.

Results

Table 1 highlights the key features of the cohort of acute medical patients studied. Between 2002 and 2008, 25.8% of the 23,114 patients were over the age of 75 years. As would be expected, age was an important and independent determinant of outcome. For this group (i.e. >75 years), the 30-day mortality was 20.7% compared with 4.5% for those younger. The comparable mortality rates for the under 65 and for those between 65 and 75 years were 2.9 and 10.5%, respectively.

Table 1 profiles the key features of the population studied. The populations quantiles are a frequency-based descriptor, with cut-offs at the 10, 25, 75 and 90 centiles of the distribution. The oldest 25% of the population (upper two quantiles) had unadjusted odd ratios for mortality of 2.73 (95% CI 2.35, 3.03) and 4.65 (95% CI 4.18, 5.19), respectively. Table 2 presents data from a logistic regression model; this examines the modification of the univarate risk when other significant predictors (covariates) of 30 days mortality are included in the model. Effectively, the extent to which the univariate risk, a composite, will be adjusted downwards by other predictors is investigated. The OR for the Charlson co-morbidity index was 1.26 (95% CI 1.19, 1.34); this is interpreted as a 26% increased risk for death at 30 days, with increasing co-morbidity burden (0–6 range). There is an incremental increase in risk as one compares a Charlson score of 0 (as reference score) with 1 (OR 1.13) versus a Charlson score of 2 or more (OR 2.7). There was only a small interaction between age and Charlson co-morbidity index in terms of outcome prediction in the over 75 years age group. The composition of the cohort year on year was explored, and no difference was found with respect to either age composition or major disease category profile over the period of our observations. Overall, the effect of our acute medical admission initiative can be inferred from the OR for time; this shows a 56% RRR decline in 30-day all-cause mortality (OR 0.44: 95% CI 0.37, 0.52). Importantly, time and age >75 years did not interact; we can therefore infer that the mortality reduction observed also applied to the over 75 years group.

We used the nominal logistic fit of mortality to test whether major disease category (cardiovascular, respiratory or neurological disease) interacted with quantiles 4 and 5 when predicting outcome; there was no effect. Our acute illness severity score was a very powerful predictor of outcome; there is a 53% increase in 30-day mortality as one processes up the deciles of calculated risk (OR 1.53: 95% CI 1.47, 1.59). In estimates of the impact of acute illness severity for our elderly cohort, we modified the score to exclude age in its computation. For the remaining parameters, the AUROC to predict an in-hospital death at 5 days was 0.92 in the derivation dataset and 0.92 in the validation and at 30 days 0.87 and 0.88, respectively.

Table 1. Details of emergency medical admissions 2002–08

Variable				
Gender				
Male	11,130 (48.2%)			
Female	11,984 (51.8%)			
Total	23,114 (100%)			
Age (years), median (IQR)	58.3 (37.6–75.4)			
Length of stay (days), median (IQR)	4.6 (1.8–9.2)			
Charlson co-morbidity index				
>0	41.2%			
>1	17.1%			
By group[a]				
Age	Mean (SD)	Mortality		
<75 years	47.4 (17.1)	776/17,421 = 4.5%		
>75 years	82.6 (5.2)	1180/5693 = 20.7%		
By quantile[b]				
Age	*N*	Mortality (%)	OR (95% CI)*	
			Unadjusted	Adjusted
21.6 ± 2.8	2,312	0.4	0.04 (0.02, 0.07)	0.11 (0.05, 0.2)
31.5 ± 3.4	3,467	1.0	0.09 (0.07, 0.13)	0.17 (0.11, 0.25)
57.8 ± 11.2	11,556	6.4	0.59 (0.54, 0.65)	0.57 (0.51, 0.65)
79.4 ± 2.3	3,468	16.9	2.73 (2.36, 3.03)	1.64 (1.43, 1.87)
88.1 ± 3.5	2,311	24.9	4.65 (4.18, 5.19)	3.09 (2.67, 3.58)

[a]Stratified by age over or under 75 years.
[b]Stratified by age at admission (<10, 10–25, 25–75, 75–90 and >90%) with unadjusted ORs for in-hospital death.
*$P < 0.0001$ between groups.

Table 2. Predictors of an in-hospital death

Parameter	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	*P*-value
MDC 4	2.17 (1.93, 2.43)	1.82 (1.53, 2.18)	<0.0001
MDC 5	1.08 (0.93, 1.24)	1.44 (1.16, 1.79)	<0.0009
MDC 1	0.65 (0.55, 0.77)	2.34 (1.84, 2.97)	<0.0001
Readmission	1.12 (1.09, 1.14)	1.05 (1.02, 1.09)	<0.002
ICU admission	14.6 (12.1, 17.6)	9.91 (7.69, 12.8)	<0.0001
Charlson index	1.64 (1.58, 1.71)	1.26 (1.19, 1.34)	<0.0001
Troponin+	8.95 (7.84, 10.2)	3.66 (3.00, 4.47)	<0.0001
Blood transfusion	7.08 (5.92, 8.46)	1.79 (1.38, 2.32)	<0.0001
Year quarter	0.93 (0.89, 0.98)	0.92 (0.86, 0.98)	<0.007
AMAU effect	0.58 (0.52, 0.65)	0.44 (0.37, 0.52)	<0.0001
>75 years	5.60 (4.99, 6.30)	2.93 (2.50, 3.42)	<0.0001
Illness severity	1.84 (1.78, 1.90)	1.53 (1.47, 1.59)	<0.0001

Data adjusted for acute illness severity and log length of stay as described. The OR for LOS was 0.6 (95% CI 0.33, 1.1, $P = 0.1$). MDCs are (4) respiratory, (5) circulatory and (1) nervous. Blood transfusion is units of transfusion >0. AMAU effect: comparison of two consecutive periods (first: 1 January 2002–30 March 2005; second). The ORs for re-admissions, Charlson index and illness severity are unit ORs and reflect change in risk with increasing score. For any re-admission, the value 1.05 indicates an approximate 5% increased risk of an in-hospital death with each re-admission; illness severity indicated an approximate 53% increased risk of an in-hospital death at each decile of the risk score. The unadjusted univariate OR for >75-year group for an in-hospital death was 5.60 (4.99, 6.3). When the model is adjusted for the interaction between age over 75 and co-morbidity, the OR adjusts to 3.22 (2.67, 3.6).

The unadjusted OR for a 30-day death in the over 75 of 5.60 (95% CI 4.99, 6.3) fell to 4.69 (95% CI 4.04, 5.44) when adjusted for all other factors but excluding acute illness severity and 2.93 (95% CI 2.50, 3.42) when adjusted for all factors including acute illness severity. Allowing for the interaction of age and co-morbidity, the OR adjusted to 3.22 (95% CI 2.63. 3.6).

Discussion and conclusion

Our data, as would be predicted, described a fourfold unadjusted increased 30-day in-hospital mortality risk for those over 75 years who were admitted to a large teaching hospital with a medical emergency. However, the expectation that this increased risk was largely age-related was not supported by the data. Our expectation was that this age-related increased mortality would primarily be driven by a greater chronic disease burden. Clearly, the large downwards adjustment with illness severity as a covariate suggested that the very elderly were much sicker. The importance of illness severity has been highlighted with respect to older patients admitted to intensive care [20].

Our AMAU initiative has described a 50% relative risk reduction in mortality [8]; our results suggest that the elderly as well as younger benefited. Interestingly, this was not demonstrated in a different model of AMAU care [5] where patients were triaged down specialty lines at an early stage. The benefit of 'system effects' of care has been described for stroke unit [21, 22] and coronary care unit care [23].

This information should be fed into health planning as recommended by the Declaration of Innsbruck [24]. Given that the elderly patients from our cohort were sicker at the time of admission, and that this followed on to a higher 30-day mortality rate, one can question whether 'admission avoidance schemes' are necessarily a comprehensive solution for older medical patients. The benefit of early discharge schemes/home hospital for older people is questionable in light of a Cochrane review performed in this area [25]. The transition to new models of care should be informed by data rather than opinion. This is pertinent today in light of the move to new work practices as a result of the European Working time directive. Some of the commentary that followed on the Calman report in the 1990s appears pertinent [26, 27].

A weakness in our data was the lack of functional data. The ACME project [13] clearly demonstrated how simple functional and cognitive data predict across the spectrum from mortality through length of stay and into discharge destination. We will explore adding this information into our database and believe that it will help illuminate many other important questions in elderly care. For example, a group from our institution have reported on the survival of elderly patients discharged to extended nursing care [28]. A challenge will arise in standardising the collection of functional data and perhaps adopting the approach of the International classification of functioning, disability and health would be prudent [29, 30].

A practical question arises as to how best to liaise with medicine for the elderly in the acute management of these patients. As mentioned in the introduction, medicine for the elderly are not part of the acute call rota in our hospital but offer a consultation model. It would be worthwhile exploring a direct geriatric liaison service within the AMAU, further perhaps the addition of the geriatric service within the matrix of the AMAU rota would enhance the system effect, particularly within the elderly cohort. A further question is whether chronic disease management is optimal in older patients. This question arises on the basis that there is no significant difference between the old and young cohorts in respect of chronic disease load, but there is a clear separation in terms of severity of illness at presentation. Hence, consideration should be given to models of chronic disease care for older patients in an effort to optimise status and function.

Key points

- Older patients are sicker at the time of emergency admission.
- Those over 75 are 2.9 times more likely to die allowing for acute illness severity.
- Service planning for older patients should be based around comprehensive chronic disease management programmes.

Conflicts of interest

None of the authors have any conflict of interest.

Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

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