The challenges of population ageing: accelerating demand for emergency ambulance services by older patients, 1995–2015

Judy A Lowthian, Damien J Jolley, Andrea J Curtis, Alexander Currell, Peter A Cameron, Johannes U Stoelwinder and John J McNeil

ABSTRACT

Objective: To measure the growth in emergency ambulance use across metropolitan Melbourne since 1995, to measure the impact of population growth and ageing on these services, and to forecast demand for these services in 2015.

Design and setting: A population-based retrospective analysis of Ambulance Victoria's metropolitan emergency ambulance transportation data for the period from financial year 1994–95 to 2007–08, and modelling of demand in the financial year 2014–15.

Main outcome measures: Numbers and rates of emergency ambulance transportations.

Results: The crude annual rate of emergency transportations across all age groups increased from 32 per 1000 people in 1994–95 to 58 per 1000 people in 2007–08. The rate of transportation for all ages increased by 75% (95% CI, 62%–89%) over the 14-year study period, representing an average annual growth rate of 4.8% (95% CI, 4.3%–5.3%) beyond that explained by demographic changes. Patients aged ⩾ 85 years were eight times (incident rate ratio, 7.9 [95% CI, 7.6–8.3]) as likely to be transported than those aged 45–69 years over this period. Forecast models suggest that the number of transportations will increase by 46%–69% between 2007–08 and 2014–15, disproportionately driven by increasing usage by patients aged ⩾ 85 years.

Conclusions: These findings confirm a dramatic rise in emergency transportations over the study period, beyond that expected from demographic changes. Rates increased across all age groups, but more so in older patients. In the future, such acceleration is likely to have major effects on ambulance services and acute hospital capacity. This calls for further investigation of underlying causes and alternative models of care.

MJA 2011; 194: 574–578

eMJA Rapid Online Publication 23 May 2011

Over the past 20 years, there has been a sustained rise in demand for emergency ambulance services across the developed world.[1-4] Growth in emergency transportations is an important determinant of emergency department attendances.[5] In particular, transport of older patients has a significant impact on acute hospital capacity because of high admission rates and long lengths of stay.[6,7] Resultant pressure compromises access, quality of care and patient safety, with emergency department congestion and overcrowding reported regularly.[8-11] The strains on ambulance services, however, are less well documented.

Demand on ambulance services encompasses telephone requests via Triple Zero (000) to ambulance call centres, dispatch of paramedics and ambulance vehicles (road and air, emergency and non-emergency), treatment of patients at the scene without transportation, and transport of patients to an emergency department, a non-acute care facility or the patient's place of residence.

To date, researchers and service providers have focused on describing the increasing rate of ambulance use and the effect on response times over short periods.[1-4,12-14] Some have examined the influence of demographic and health system dynamics on the use of emergency resources. Two recent reviews have suggested that changes in demographics, population health, health system practices, public expectations and accessibility of ambulance services contribute to rising demand, with population growth and ageing proposed as key drivers.[15,16]

Older people will make up an increasingly larger proportion of the population in the future.[17] About 13% of the population in the United Kingdom, United States and Australia are currently aged over 65 years. It is projected that this will increase to 25% over the next 25 years, with the proportion aged over 85 years rising from 1.6% to around 5%.[18-20]

We aimed to measure the growth in emergency road ambulance transportations in metropolitan Melbourne since 1995, to measure the impact of population growth and ageing on these services, and to forecast demand for these services in 2015.

METHODS

We undertook a retrospective analysis of administrative data collected by Ambulance Victoria (Melbourne's sole provider of emergency ambulance responses) for all emergency ambulance transportations in metropolitan Melbourne over the 14-year period from the financial year 1994–95 to 2007–08. We also modelled demand in the financial year 2014–15. The study was approved by the Monash University Human Research Ethics Committee and Ambulance Victoria's Research Governance Committee.

Data

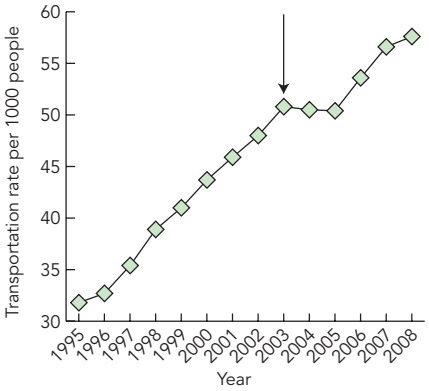
Emergency transportation data were provided in a de-identified format by Ambulance Victoria. Data elements comprised demographic characteristics (including age and sex) and clinical condition of the patient as identified at the time of the request for assistance using the Advanced Medical Priority Dispatch System (Priority Dispatch Corporation, Salt Lake City, Utah, USA). Population data published by the Australian Bureau of Statistics[21-23] were used to calculate emergency transportation rates by age and sex. Projected population estimates from the Australian Bureau of Statistics (based on conservative assumptions of fertility, life expectancy and migration) were used to forecast demand for emergency transportation in 2014–15.

Analysis

All analyses were performed using Stata version 11 (StataCorp, College Station, Tex, USA). The primary outcome event was transportation in an emergency ambulance. We used confidence intervals to quantify the precision of our estimates throughout.

We calculated the average rate of transportation by age and sex over the 14-year study period and the expected number of transportations per year, aggregating age and sex. Observed and expected numbers of transportations were used to generate a standardised transportation ratio for each year. This was used to estimate the increase in transportations over time, allowing for

1 Emergency transportation rates for males and females of all ages, Melbourne (1994–95 to 2007–08 financial years)*



* Arrow denotes introduction of referral service. ◆

changes in the demographic structure of the population.

Using log-linear regression with weights inversely proportional to the variance of the outcome variable, we modelled the main effects and interactions of sex and age, and of age and time on the logarithm of the transportation rate while controlling for the introduction of a referral service. This was compared with a linear model to test an alternative method of modelling.

We extrapolated the models for transportation rates to 2014–15. Predicted numbers of transportations were calculated by multiplying predicted rates by projected population estimates.

RESULTS

During the 14 years studied, there were 2 227 144 emergency ambulance transportations in metropolitan Melbourne. The crude rate of emergency transportation for males and females of all ages increased from 32 per 1000 people in 1994–95 to 58 per 1000 people in 2007–08 (Box 1). The rate decreased in late 2003 following the introduction of an ambulance referral service designed to curb demand — after adjusting for the effects and interactions of age, sex and the referral service, the rate was decreased by 10%. However, the rate increased again by 2006 to levels above those in 2003. For suitable patients, the referral service enables provision of self-care telephone advice, referral to a non-emergency transport service or referral to a community-based service as an alternative to emergency ambulance dispatch at the time of the initial telephone call. Ambulance Victoria data for 2011 indicate that about 8% of callers are currently directed to one of these options.

Transportation rate increases were only partly accounted for by changes in population size and age and sex distribution. The rate of transportation for all ages increased by 75% over the 14 years studied (95% CI, 62%–89%). This represented an average annual growth rate of 4.8% (95% CI, 4.3%–5.3%) beyond that explained by demographic changes. There were similar relative proportional increases in all age groups and the highest absolute rates were in the oldest patients (Box 2). Transportation rates relative to those in 1994–95 increased for males and females in all age groups in a linear and uniform manner (Box 3), suggesting an exponential increase in the transportation rates over time.

Patients aged ⩾ 85 years were eight times (incident rate ratio, 7.9 [95% CI, 7.6–8.3]) as likely to be transported as those aged 45–69 years. Their transportation rate rose from 248 to 474 per 1000 population, and increased 3.1% faster per year (95% CI, 2.1%–4.1%) than the transportation rate for patients aged 45–69 years. By 2007–08, the proportion of Melbourne's population aged ⩾ 85 years rose from 1.1% to 1.6%, yet the proportion of emergency transportations accounted for by this group rose from 8.4% to 13.6%.

Annual standardised transportation ratios indicated a significant rise in transportations despite taking population growth and ageing into account. Compared with 1994–95, the number of transportations observed in 2007–08 was 68% greater than expected.

For older patients, the predominant reasons for emergency ambulance requests were falls, chest pain and breathing problems. The proportional increases in transportations of patients with each of these conditions were similar.

When log-linear modelling, which is usually applied to rates of occurrence of events, was tested against linear modelling of the data to 2007–08, the difference in performance was imperceptible. We therefore used both models to forecast demand in 2014–15 (Box 2). The total number of emergency transportations in metropolitan Melbourne could increase by 46%–69% by 2014–15.

The projected numbers and rates of transportations by age group to 2014–15 (Box 4 and Box 5) demonstrate that demand by people aged ⩾ 85 years will continue to accelerate in the future. Among those aged ⩾ 85 years, the rate could rise from the observed 474 per 1000 people in 2007–08 to more than 800 per 1000 people in 2014–15, with the absolute numbers of transportations rising more than twofold.

DISCUSSION

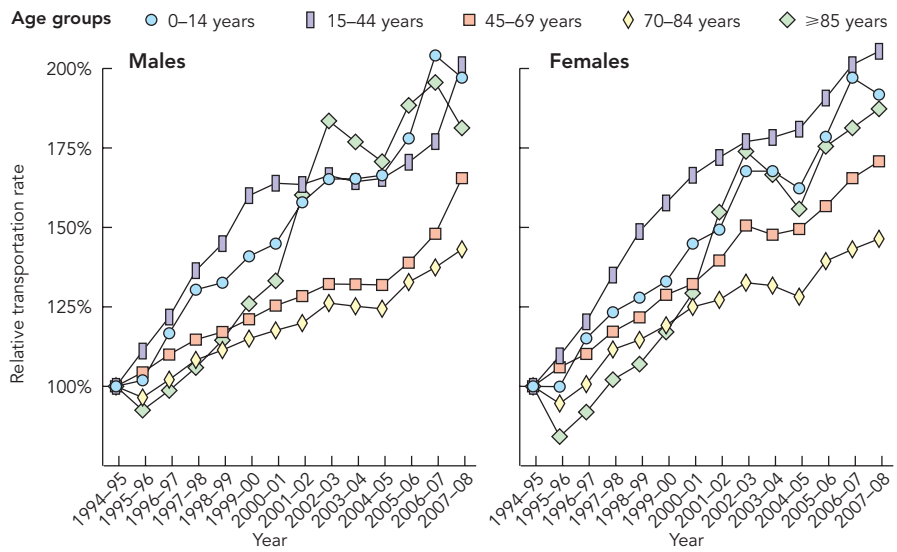
Our study shows that there has been a dramatic rise in emergency transportations in Melbourne over the 14-year period to June 2008. The association that we identified between transportation rates and increasing age concurs with previous findings.[2,15,25-27] However, to our knowledge, this is the first study to identify an increasing and accelerated rate of demand by patients aged ⩾ 85 years compared with other age groups, which cannot be explained by demographic changes alone, and it is the first to model future demand while taking population ageing into account.

Demand for emergency health care services among older patients is driven by many factors. Older patients often present to emergency departments with more complex

2 Total numbers of emergency transportations and transportation rates by age group, Melbourne (1994–95, 2007–08 and 2014–15 financial years)

	1994–95	2007–08	2014–15 forecasts	
	Observed	Observed	Linear model	Log-linear model
Population (million)[23,24]	3.27	3.92	4.24	4.24
No. of transportations	104 028	225 865	330 332	382 260
Rate per 1000 people				
All ages (crude)	31.8	57.6	77.9	90.2
0 to 14 years	10.7	21.2	27.2	34.0
15 to 44 years	18.3	34.8	48.1	53.5
45 to 69 years	33.6	53.4	64.6	73.3
70 to 84 years	147.0	211.2	255.5	283.9
⩾ 85 years	247.6	474.0	651.0	843.7

3 Emergency transportation rates by sex and age group, relative to rates for the financial year 1994–95, Melbourne (1994–95 to 2007–08 financial years)



clinical conditions than younger patients.[6,7] The most commonly reported reasons for transportation of older patients in our study were similar to those identified previously [2,25,28] and no specific condition was responsible for the increasing ambulance use; falls, chest pain, breathing problems and lightheadedness have been recognised as ailments associated with seeking health care.[29] Reduced capacity to care for older relatives and an increasing proportion of the older population living alone,[30] alongside reduced access to primary health care,[31,32] can leave older patients with few alternatives for accessing health care, particularly outside normal working hours. Recent improvements in health awareness and increasing community expectation may also be factors.[33] In addition, limited price signals (low or no cost) could drive ambulance use by older people.[16] In Melbourne, funding arrangements via the government for a low-cost ($70) annual subscription ensure that the majority (86%) of patients transported have no out-of-pocket expense, and pensioners are entitled to free transport.

Ambulance services in the UK and Australia have taken steps to combat rising demand.[34,35] Our study showed that introduction of a referral service reduced the rate of transportations but did not slow the steady increase over time. Although the referral service is diverting an increasing number of emergency requests to alternative resources, growth rates in transportation have returned to the historical norm. This shows that service providers and funding agencies across the continuum of emergency health care need to prioritise working together to develop a coordinated whole-of-system approach, including innovative models of out-of-hospital patient-centred care. Other demand management strategies that have been introduced include the UK's NHS Direct and Victoria's NURSE-ON-CALL and after-hours general practitioner clinics, but these have had little impact on reducing demand on emergency resources.[36,37] The effects of other strategies that have been implemented — including outreach programs such as hospital-in-the-home and hospital-in-the-nursing-home, mobile specialist teams, and urgent-care walk-in clinics — are yet to be rigorously evaluated.[38,39]

As numbers and rates of presentations of older patients with complex illnesses and medication regimens increase, the training of emergency health care workers must ensure that they are equipped to meet the special care needs of older patients. This includes acknowledgement of limitations to care, especially with respect to aggressive treatment being inappropriate in very elderly and palliative-care patients.[39] Service providers in the UK and Australia have recently introduced non-transportation protocols that extend paramedics' duties to "treat and leave" patients at their place of residence. In addition, UK service providers have begun conveying patients to alternative, more appropriate health services, instead of emergency departments.[40,41] Evaluation of the safety and efficacy of these alternative services is ongoing.[42]

A strength of our study is its population-based and longitudinal nature, which enabled analysis of 2.27 million emergency transportations over 14 years. The only other longitudinal study that we are aware of examined call rate data from the sole provider of ambulance services in London for three 1-week periods between 1989 and 1999.[3] A limitation of our study is that it was not possible to identify the number of repeated transportations of same individuals, as the data were de-identified. Also, the predictions are based on past trends in transportation and demographics and, as such, rely on the same trends prevailing over the forecast period.

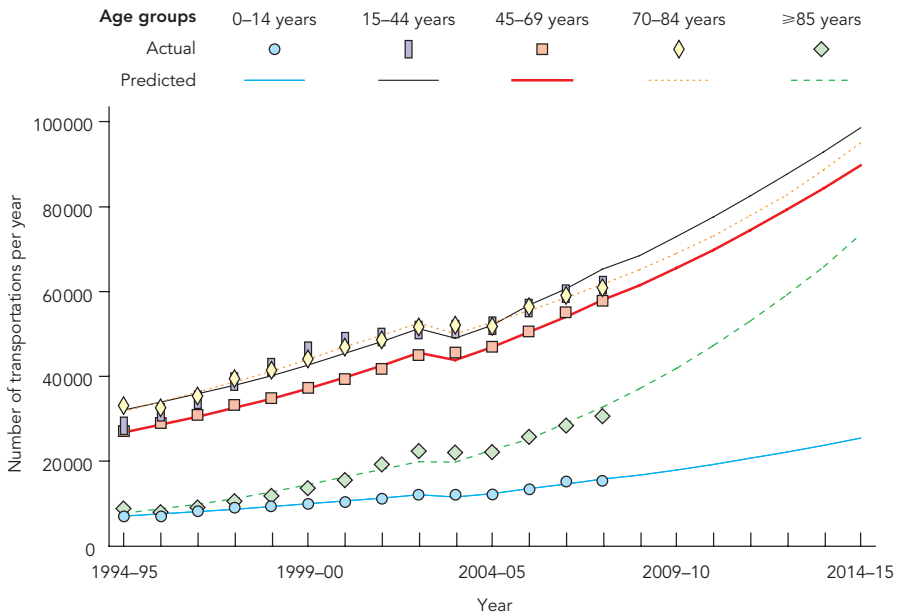
Our findings show a persistent rise in emergency transportations in Melbourne from 1994–95 to 2007–08, after adjustments for population growth and ageing. By 2014–15, the absolute increase is likely to be substantially greater among older patients, which will have a dramatic impact on the continuum of emergency health care. In a climate of global financial constraint, we believe our results indicate an urgent need for a coordinated response by policymakers and service providers to this increasing demand.

4 Predicted emergency transportation rates and numbers of transportations in the financial year 2014–15 by age group using log-linear model, Melbourne

Age group	Rate per 1000 people (95% CI*)	No. of transportations (95% CI*)
0–14 years	34 (30–38)	25 430 (22 729–28 132)
15–44 years	54 (51–57)	98 582 (93 065–104 100)
45–69 years	73 (69–77)	89 794 (84 571–95 017)
70–84 years	284 (268–300)	95 004 (89 740–100 268)
⩾ 85 years	844 (770–917)	73 450 (67 236–79 663)
All ages	—	382 260 (357 341–407 180)

*95% CIs are based on prediction model only, using the bootstrap method, as estimated precision of projected population estimates is not available. ◆

5 Actual and predicted numbers of emergency transportations by age group using a log-linear model, Melbourne (1994–05 to 2014–15 financial years)



ACKNOWLEDGEMENTS

Judy Lowthian is the recipient of a National Health and Medical Research Council postgraduate research scholarship to undertake her doctorate on emergency demand.

COMPETING INTERESTS

None identified.

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Provenance: *Not commissioned; externally peer reviewed.*

(Received 8 Dec 2010, accepted 11 Apr 2011)

See pages 564 and 570. ❑