Outcome of elderly patients who receive intensive care at a regional hospital in Hong Kong

HP Shum *, KC Chan, HY Wong, WW Yan

ABSTRACT

Objective: To evaluate the clinical outcome (180-day mortality) of very elderly critically ill patients (age ≥80 years) and compare with those aged 60 to 79 years.

Design: Historical cohort study.

Setting: Regional hospital, Hong Kong.

Patients: Patients aged ≥60 years admitted between 1 January 2009 and 31 December 2013 to the Intensive Care Unit of the hospital.

Results: Over 5 years, 4226 patients aged ≥60 years were admitted (55.5% total intensive care unit admissions), of whom 32.8% were aged ≥80 years. The proportion of patients aged ≥80 years increased over 5 years. As expected, those aged ≥80 years carried more significant co-morbidities and a higher disease severity compared with those aged 60 to 79 years. They required more mechanical ventilatory support, were less likely to receive renal replacement therapy, and had a higher intensive care unit/hospital/180-day mortality compared with those aged 60 to 79 years. Nonetheless, 71.8% were discharged home and 62.2% survived >180 days following intensive care unit admission. Cox regression analysis revealed that Acute Physiology and Chronic Health Evaluation IV-minus-Age score, emergency admission, intensive care unit admission due to cardiovascular problem, neurosurgical cases, presence of significant co-morbidities (diabetes mellitus, metastatic carcinoma, leukaemia, or myeloma), and requirement for mechanical ventilation independently predicted 180-day mortality.

Conclusions: The proportion of critically ill patients aged ≥80 years increased over a 5-year period. Despite having more significant co-morbidities, greater disease severity, and higher intensive care unit/hospital/180-day mortality rate compared with those aged 60 to 79 years, 71.8% of those ≥80 years could be discharged home and 62.2% survived >180 days following intensive care unit admission. Disease severity, presence of co-morbidities, requirement for mechanical ventilation, emergency cases, and admission diagnosis independently predicted 180-day mortality.

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New knowledge added by this study

- This study provides up-to-date information on the outcome for critically ill elderly patients. It is currently the largest study focused on the local population.

Implications for clinical practice or policy

- Despite having more significant co-morbidities, greater disease severity, and a higher intensive care unit (ICU)/hospital/180-day mortality rate compared with those aged 60 to 79 years, our study showed that >70% of critically ill patients aged ≥80 years could be discharged home and their 180-day survival rate was >60%. Such information supports ICU admission for those aged ≥80 years. We recommend further studies to explore the long-term functional outcome of those critically ill elderly patients and the potential health economic impact associated with increased ICU admission for those aged ≥80 years.

Introduction

According to the Hong Kong Population Projections 2012-2041 report, the proportion of Hong Kong population aged ≥80 years is projected to increase markedly from 273 000 (3.9%) to 957 000 (11.3%) by the year 2041.[1] Improvements to health-care provision and environmental factors are responsible for this change. The very elderly patients consume a higher proportion of health-care resources due to the presence of significant co-morbidities.[2] Similar to most other specialties, intensive care units (ICUs) face an increasing demand for care by elderly patients. A large multicentre cohort study conducted in Australia and New Zealand reported that the ICU admission rate for those aged ≥80 years increased by 5.6% per year.[3] An Austrian group noted a similar trend.[4] Intensive care unit is an expensive and limited resource. In theory, the decision to admit or decline a patient from ICU care should not depend solely on the patient's age, although some earlier studies hinted at such practice.[5,6] The debate on the role of advanced age, as opposed to severity of illness, on clinical outcome of these critically ill elderly patients remains unresolved. Commonly used ICU prognostic scores, eg Acute Physiology and Chronic Health Evaluation (APACHE) score and simplified acute physiology score (SAPS), include 'age' as one of the components of a mortality risk prediction model. Although some studies have highlighted the importance of age in patient outcome,[3,7,8] others have concluded that age was not predictive of a poor prognosis in ICU.[9,10] They suggest that severity of illness or premorbid functional status are more important determinants of ICU outcome.[9,10] Hong Kong, which has the longest life expectancy in the world, has few data focused on the outcome for critically ill elderly patients.[11] Our primary objective of this study was to evaluate the clinical outcome (180-day mortality) of very elderly patients (≥80 years old) and compare it with that of patients aged 60 to 79 years. The secondary objective was to determine factors associated with the survival of elderly patients (aged ≥60 years) who require ICU care.

老年病者入住香港一所分區醫院深切治療部後的結果測量

沈海平、陳勁松、黃海恩、殷榮華

目的：評估危重老年病者（80歲或以上）的臨床療效（180天死亡率），並與60至79歲病者的臨床療效作比較。

設計：歷史隊列研究。

安排：香港一所分區醫院。

患者：2009年1月1日至2013年12月31日期間入住上述醫院深切治療部（ICU）的60歲或以上病者。

結果：5年間共有4226名年齡60歲或以上的病者入住ICU，佔總入住人數的55.5%，當中32.8%為80歲或以上的病者。同期80歲以上病者的比例增加。一如預期，與60至79歲病者比較，80歲或以上老年病者多同時罹患兩種或以上顯著和較嚴重的疾病，而且他們需要更多機械通氣支援、較少機會接受腎臟替代治療，以及有較高的ICU、院內和180天死亡率。研究發現71.8%的80歲或以上老年病者能出院，62.2%能存活超過180天。Cox迴歸分析顯示以下多項因素能獨立預測180天死亡率：APACHE IV減去年齡的分數、急診入院、因心臟血管及腦外科等問題入住ICU、同時罹患多種顯著疾病（糖尿病、轉移癌、白血病或骨髓瘤），以及須使用機械通氣支援。

結論：在這5年間，80歲以上危重病者入住ICU的比例有所上升。雖然相對於60至79歲病者，他們較多同時罹患兩種或以上顯著和較嚴重的疾病，更有較高的ICU、院內及180天死亡率，但是71.8%仍能出院，62.2%更能存活超過180天。疾病的嚴重程度、同時罹患多種顯著疾病、須使用機械通氣支援、急診入院及入院時的診斷均能獨立預測180天死亡率。

Methods

This study was approved by the hospital Ethics Committee and written informed consent was waived. This study was a retrospective, single-centre, cohort study conducted at the ICU of Pamela Youde Nethersole Eastern Hospital (PYNEH), a 2000-bed acute care regional hospital that provides comprehensive services except cardiothoracic surgery, transplant surgery, and burns. The ICU is a 22-bed closed mixed medical-surgical unit with an average admission of 1400 patients per year. All patients who were admitted to the ICU between 1 January 2009 and 31 December 2013 were evaluated. During the study period, there were no changes to ICU operation guidelines or major clinical decision makers. Patients aged ≥60 years were recruited for this study. The cutoff value of 60 years was adopted based on the United Nations definition of an older or elderly person.[12] Those for whom there were insufficient data for analysis or who remained in the ICU for <4 hours were excluded. Admissions that involved the same patient for different hospitalisation episodes were treated independently.

The following data were collected: demographics, significant co-morbidities (hypertension, congestive heart failure, diabetes mellitus, ischaemic heart disease, ischaemic or haemorrhagic stroke, chronic respiratory failure, end-stage renal failure requiring dialytic support, liver cirrhosis or liver failure, haematological malignancy, or immunosuppressed status), admission diagnosis, emergency or elective cases, ICU and hospital length of stay, and ICU and hospital outcomes. Mortality in ICU was defined as PYNEH ICU death within the index admission. Hospital mortality was defined as PYNEH death within the index admission. The 180-day mortality was defined as death within 180 days, calculated from ICU admission.

Patient's severity of illness was quantified using the APACHE IV system.[13] This is a severity-adjusted methodology that predicts outcome for critically ill adult patients and comprises the following major components: (1) acute physiology score focused on cardiopulmonary parameters and laboratory data retrieved as the worst value within the first 24 hours of ICU admission, (2) significant co-morbidities, (3) age, (4) ICU admission disease classification, and (5) patient's length of stay in the hospital prior to ICU admission. All patient data were collected from the hospital's information system and an ICU clinical information system (IntelliVue Clinical Information Portfolio, Philips Medical Systems, Amsterdam, The

Netherlands). Patients were followed up until death or 180 days from ICU admission, whichever was the earlier. The most updated mortality and survival data were obtained from the Clinical Management System.

Statistical analyses

Data were reported as frequencies, percentages, means, and standard deviations. Univariate analyses were performed using Chi squared test, Fisher's exact test, and Student's *t* test where appropriate. Cox regression analysis using a forward stepwise strategy was performed (on factors with P<0.1 in univariate analyses) to determine the independent predictors of 180-day mortality. The interpretation of multivariable Cox regression analyses may carry significant problems in the presence of collinear variables such as age together with APACHE IV score, in which age is one of the prognostic components. In order to examine the effect of age per se and to avoid collinearity, age points were deducted from the total APACHE IV score to generate the APACHE IV-minus-Age score. Trend analysis was performed using Chi squared test for trend in proportions. All analyses were performed using the Statistical Package for the Social Sciences (Windows version 16.0; SPSS Inc, Chicago [IL], US) and R statistical program version 3.2 (R Foundation, http://www.r-project.org/). A P value of <0.05 was considered statistically significant and all statistical tests were two-tailed. The APACHE IV standardised mortality ratio (SMR) was calculated by dividing the observed mortality by the predicted mortality based on the APACHE IV score. An SMR of <1 indicated better performance than expected and >1 indicated suboptimal performance.[13]

Results

All patients aged ≥60 years

Over the 5-year period, 4247 patients aged ≥60 years were admitted to the ICU. After exclusion of 21 patients who had insufficient data for analysis (due to incomplete APACHE form data entry) or who remained in the ICU for <4 hours, 4226 patients were recruited. They represented 55.5% of total ICU admissions. This proportion was similar across 5 years (57.4% in 2009, 55.9% in 2010, 51.9% in 2011, 56.6% in 2012, and 55.9% in 2013; P value not significant). Emergency admission accounted for 83.8% of cases and 39.6% were for postoperative care. The mean APACHE IV predicted risk of death was 32%. The overall observed ICU mortality was 12.5% and the hospital mortality was 20.8% that translated into an APACHE IV SMR of 0.66. The ICU mortality (13.8% in 2009, 12.9% in 2010, 10.8% in 2011, 11.7% in 2012, and 13.2% in 2013) and hospital mortality (21.5% in 2009, 21.0% in 2010, 17.4% in 2011, 22.3% in 2012, and 21.6% in 2013) did not change significantly over 5 years. The overall 180-day mortality was 29.5% and likewise showed no significant change over 5 years. The outcome for all patients was successfully traced from the Clinical Management System.

Difference between patients aged 60 to 79 years and those ≥80 years

Among those ≥60 years old (4226 patients), 32.8% were aged ≥80 years, representing 18.2% of total ICU admissions during the study period. The proportion of patients aged ≥80 years increased over 5 years (16.2% in 2009, 18.9% in 2010, 16.0% in 2011, 20.3% in 2012, and 19.4% in 2013; P=0.006). Compared with patients aged 60 to 79 years, those ≥80 years old were more commonly female, admitted as an emergency, had more co-morbidities (had more ischaemic heart disease, but less likely to have renal failure on dialysis, cirrhosis, or malignancy), and had greater disease severity as assessed by APACHE IV-minus-Age score (Table 1). With regard to clinical outcome, those ≥80 years required more mechanical ventilatory support (55.5% for ≥80 years vs 48.2% for 60-79 years; P<0.001) and were less likely to receive renal replacement therapy (12.2% for ≥80 years vs 16.3% for 60-79 years; P=0.001). They also had higher ICU mortality (16.9% for ≥80 years vs 10.3% for 60-79 years; P<0.001), hospital mortality (28.3% for ≥80 years vs 17.2% for 60-79 years; P<0.001), and 180-day mortality (37.8% for ≥80 years vs 25.5% for 60-79 years; P<0.001). Their ICU and hospital length of stay were nonetheless similar. Despite having more significant co-morbidities, greater disease severity, and higher ICU/hospital/180-day mortality rate than those aged 60 to 79 years, 71.8% of those aged ≥80 years could be discharged home and 62.2% survived >180 days from ICU admission. Patients were divided into three age-groups namely 60-69, 70-79, and ≥80 years. Kaplan-Meier survival plot indicated a significant survival difference between the groups (log rank test P<0.001 for both ≥80 vs 60-69 and ≥80 vs 70-79 years; Fig 1). Half of all deaths occurred within the first 15 days from ICU admission. The ratio of hospital death versus ICU death was the same across the three groups of patients (1.67 for all three groups of patients).

Independent predictors of 180-day mortality

For those aged ≥80 years (Table 2), Cox regression analysis revealed that APACHE IV-minus-Age score, emergency admission, ICU admission due to cardiovascular cause, neurosurgical cases, presence of significant co-morbidities (diabetes mellitus, metastatic carcinoma, leukaemia, or myeloma), and requirement for mechanical ventilation independently predicted 180-day mortality. The

TABLE 1. Patients' baseline characteristics and outcome*

Characteristic/outcome	All patients (n=4226)	≥80 Years old (n=1388)	60-79 Years old (n=2838)	P value
Age (years)	74.7 ± 8.5	84.2 ± 3.6	70.1 ± 6.0	<0.001
Male	2497 (59.1)	721 (51.9)	1776 (62.6)	<0.001
Source of admission				0.092
General ward	1931 (45.7)	670 (48.3)	1261 (44.4)	
OT	1673 (39.6)	540 (38.9)	1133 (39.9)	
AED	559 (13.2)	162 (11.7)	397 (14.0)	
Others	63 (1.5)	16 (1.2)	47 (1.7)	
Specialty				<0.001
Medical	1820 (43.1)	607 (43.7)	1213 (42.7)	0.541
Surgical	1519 (35.9)	564 (40.6)	955 (33.7)	<0.001
NS	525 (12.4)	103 (7.4)	422 (14.9)	<0.001
ORT	217 (5.1)	89 (6.4)	128 (4.5)	0.009
Others	145 (3.4)	25 (1.8)	120 (4.2)	<0.001
Emergency case	3541 (83.8)	1246 (89.8)	2295 (80.9)	<0.001
Postoperative case	1673 (39.6)	540 (38.9)	1133 (39.9)	0.525
Significant co-morbidities				
HT	736 (17.4)	243 (17.5)	493 (17.4)	0.913
DM	1269 (30.0)	391 (28.2)	878 (30.9)	0.065
IHD	525 (12.4)	220 (15.9)	305 (10.7)	<0.001
Stroke	736 (17.4)	243 (17.5)	493 (17.4)	0.913
COPD	112 (2.7)	42 (3.0)	70 (2.5)	0.288
On dialysis	183 (4.3)	34 (2.4)	149 (5.3)	<0.001
Cirrhosis	77 (1.8)	11 (0.8)	66 (2.3)	<0.001
Lymphoma	33 (0.8)	9 (0.6)	24 (0.8)	0.579
Leukaemia/myeloma	45 (1.1)	7 (0.5)	38 (1.3)	0.016
Metastatic carcinoma	142 (3.4)	32 (2.3)	110 (3.9)	0.008
Admission diagnosis by system				
GI	1022 (24.2)	391 (28.2)	631 (22.2)	<0.001
Sepsis	751 (17.8)	257 (18.5)	494 (17.4)	0.376
Cardiovascular	544 (12.9)	210 (15.1)	334 (11.8)	0.002
Respiratory	598 (14.2)	197 (14.2)	401 (14.1)	0.956
Neurological	663 (15.7)	147 (10.6)	516 (18.2)	<0.001
Renal	192 (4.5)	43 (3.1)	149 (5.3)	0.002
Trauma	138 (3.3)	44 (3.2)	94 (3.3)	0.807
Others	318 (7.5)	99 (7.1)	219 (7.7)	0.499
Mechanical ventilation	2139 (50.6)	771 (55.5)	1368 (48.2)	<0.001
CRRT or haemodialysis	632 (15.0)	170 (12.2)	462 (16.3)	0.001
APACHE IV-minus-Age score	63.0 ± 34.4	67.4 ± 35.2	60.9 ± 33.8	<0.001
APACHE IV ROD	0.32 ± 0.29	0.39 ± 0.30	0.28 ± 0.28	<0.001
APACHE IV SMR	0.66	0.73	0.61	<0.001
ICU LOS (days)	3.8 ± 5.8	3.8 ± 5.2	3.8 ± 6.1	0.924
ICU survivor LOS (days)	3.7 ± 5.5	3.7 ± 5.0	3.7 ± 5.7	0.788
ICU mortality	527 (12.5)	235 (16.9)	292 (10.3)	<0.001
Hospital LOS (days)	22.0 ± 60.9	22.0 ± 43.3	22.0 ± 67.9	0.991
Hospital survivor LOS (days)	22.1 ± 62.9	22.4 ± 27.4	22.1 ± 72.9	0.878
Hospital mortality	880 (20.8)	393 (28.3)	487 (17.2)	<0.001
Hospital discharge destination†				0.117
Home	2482 (74.2)	714 (71.8)	1768 (75.2)	
Convalescence hospital	789 (23.6)	258 (25.9)	531 (22.6)	
Others	75 (2.2)	23 (2.3)	52 (2.2)	
180-Day mortality	1248 (29.5)	525 (37.8)	723 (25.5)	<0.001

Abbreviations: AED = accident and emergency department; APACHE = Acute Physiology and Chronic Health Evaluation; COPD = chronic obstructive pulmonary disease; CRRT = continuous renal replacement therapy; DM = diabetes mellitus; GI = gastro-intestinal; HT = hypertension; ICU = intensive care unit; IHD = ischaemic heart disease; LOS = length of stay; NS = neurosurgery; ORT = orthopaedics; OT = operating theatre; ROD = risk of death; SMR = standardised mortality ratio

* All data are shown as mean ± standard derivation or No. (%), unless otherwise specified

† Percentages are based on the number of hospital survivors in each group

findings of Cox regression analysis for those aged ≥60 are shown in Table 3. Age, APACHE IV-minus-Age score, emergency admission, ICU admission due to cardiovascular or renal cause, neurosurgical cases, presence of significant co-morbidities (diabetes mellitus, metastatic carcinoma, leukaemia, or myeloma), and requirement for mechanical ventilation or renal replacement therapy were likewise independent predictors of 180-day mortality for elderly patients ≥60 years old who received intensive care.

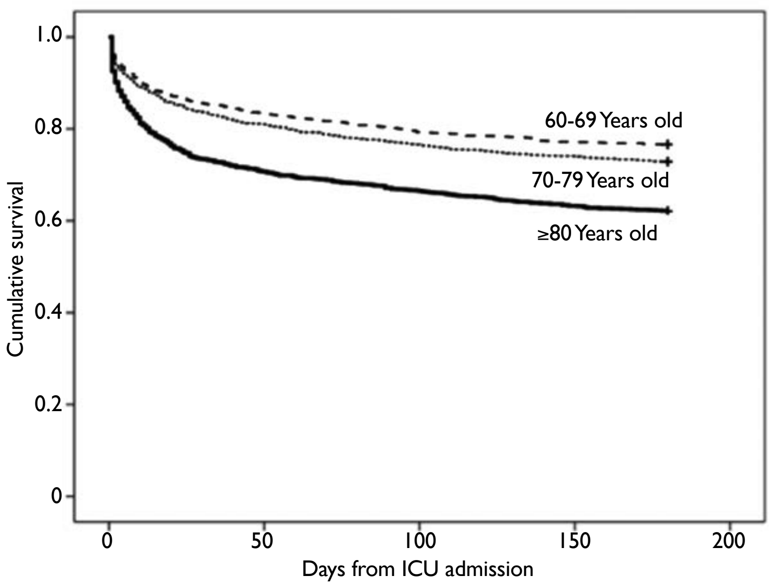

FIG 1. 180-Day survival plot for three groups of patients
Abbreviation: ICU = intensive care unit

Relationship between age, disease severity, and 180-day mortality

Patient disease severity was stratified into four groups (quartiles) according to APACHE IV-minus-Age score (1st quartile ≤37, 2nd quartile 38-55, 3rd quartile 56-81, 4th quartile >81 years). In general, the 180-day mortality rate increased with disease severity (Fig 2). The mortality rates were quite similar (with <5% difference) for those ≥80 years and those aged 60 to 79 years with low disease severity (quartiles 1 and 2) but the gap widened (with 10%-15% difference) with higher disease severity (quartiles 3 and 4).

Discussion

Our results show that the proportion of patients aged ≥80 years who required ICU care increased over 5 years (16.2% in 2009, 18.9% in 2010, 16.0% in 2011, 20.3% in 2012 and 19.4% in 2013; P=0.006). This is similar to the population growth in Hong Kong of this age-group (3.4% in 2009, 3.6% in 2010, 3.8% in 2011, 4.0% in 2012 and 4.4% in 2013).[14] They usually have more co-morbidity, are admitted to ICU as an emergency, and have higher disease severity. Their 180-day mortality rate was 1.7-fold that of 60-69 years old. The 180-day mortality rate also increased with disease severity (Fig 2). The mortality rates were quite similar (with <5% difference) for those aged ≥80 years and those aged 60 to 79 years with low disease severity but the gap widened (with 10%-15% difference) with higher disease severity. This may

TABLE 2. Independent risk factors for 180-day mortality in critically ill elderly patients (≥80 years old)

Risk factor	P value	Hazard ratio	95% CI
APACHE IV-minus-Age score	<0.001		
1st Quartile (≤37 years)		1 (Reference)	
2nd Quartile (38-55 years)		2.020	1.325-3.079
3rd Quartile (56-81 years)		3.508	2.336-5.269
4th Quartile (>81 years)		7.981	5.297-12.024
ICU admission type	0.001		
Elective		1 (Reference)	
Emergency		2.547	1.501-4.322
Presence of DM	0.001	1.387	1.136-1.693
Presence of leukaemia or myeloma	<0.001	5.093	2.249-11.534
Presence of metastatic carcinoma	0.002	2.015	1.306-3.110
Mechanical ventilation	0.002	1.420	1.134-1.778
Neurosurgical case	0.025	1.458	1.048-2.027
Admission diagnosis: cardiovascular	0.027	1.305	1.031-1.653

Abbreviations: APACHE = Acute Physiology and Chronic Health Evaluation; CI = confidence interval; DM = diabetes mellitus; ICU = intensive care unit

TABLE 3. Independent risk factors for 180-day mortality in critically ill elderly patients (≥60 years old)

Risk factor	P value	Hazard ratio	95% CI
Age (years)	<0.001		
60-69		1 (Reference)	
70-79		1.161	1.000-1.349
≥80		1.687	1.456-1.954
APACHE IV-minus-Age score	<0.001		
1st Quartile (≤37 years)		1 (Reference)	
2nd Quartile (38-55 years)		2.256	1.754-2.902
3rd Quartile (56-81 years)		3.177	2.476-4.076
4th Quartile (>81 years)		7.607	5.903-9.801
ICU admission type	<0.001		
Elective		1 (Reference)	
Emergency		1.884	1.444-2.458
Presence of DM	<0.001	1.345	1.184-1.529
Presence of leukaemia or myeloma	<0.001	3.356	2.324-4.846
Presence of metastatic carcinoma	<0.001	2.373	1.834-3.070
Mechanical ventilation	<0.001	1.477	1.277-1.708
CRRT or haemodialysis	0.020	1.204	1.029-1.408
Neurosurgical case	<0.001	1.417	1.174-1.710
Admission diagnosis: cardiovascular	0.004	1.259	1.076-1.473
Admission diagnosis: renal	0.006	1.605	1.146-2.249

Abbreviations: APACHE = Acute Physiology and Chronic Health Evaluation; CI = confidence interval; CRRT = continuous renal replacement therapy; DM = diabetes mellitus; ICU = intensive care unit

be due to a lower physiological reserve in the ≥80s that manifests when illness is severe. This study could not demonstrate how physiological reserve diminishes with age. As this was a retrospective observational study, we cannot tell whether the greater hazard for death in those ≥80 years is really related to a 'lower' physiological reserve, or whether ICU doctors/family are more likely to withhold/withdraw life support. The decision to limit therapy involves assessment of a patient's quality of life; such data were not available in this study. These findings also indicate the importance of early management of clinical deterioration in those aged ≥80 years. When disease severity progresses, mortality risk increases much faster among those ≥80 years than in those aged 60 to 79 years.

With regard to the level of treatment in the ICU, previous studies have shown that very elderly patients receive less aggressive treatment than younger patients.[15-18] In our cohort, the elderly patients were less likely to receive renal replacement therapy. Mechanical ventilation, however, was commonly performed even in those aged ≥80 years (55.5%), which is in contrast to previous studies.[4,19,20] This may have been due to a difference in case-mix and clinical practice. Lerolle et al[21] showed that the intensity of ICU treatment has increased and survival has improved over a decade for those aged ≥80 years. Ihra et al[4] also showed that the prognosis of those aged >80 years improved by 3% per year. Thus admission of such patients to ICU for a trial

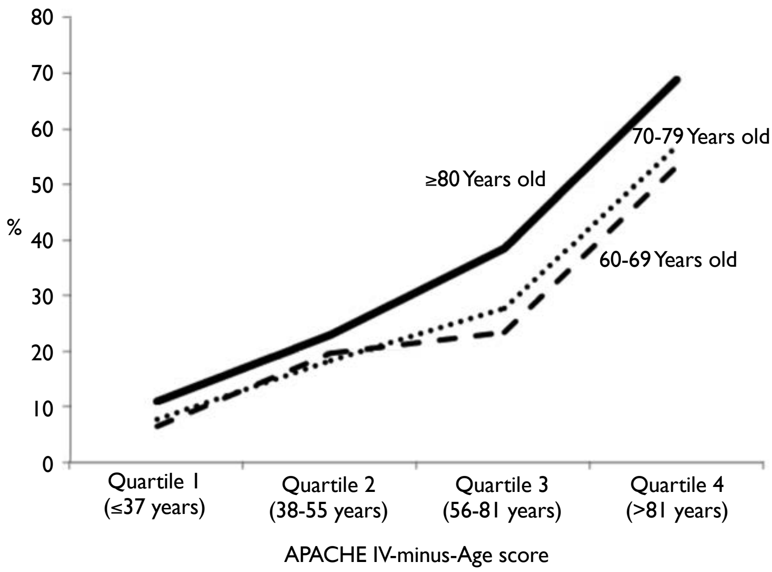

FIG 2. Percentage of 180-day mortality stratified by age and APACHE IV-minus-Age score
Abbreviation: APACHE = Acute Physiology and Chronic Health Evaluation

TABLE 4. Comparison with overseas multicentre studies

	Shum et al (present study)	Nielsson et al[20]	Andersen and Kvåle[19]	Ihra et al[4]	Bagshaw et al[3]	Reinikainen et al[30]
Year of publication	2015	2014	2012	2012	2009	2007
Country	Hong Kong	Denmark	Norway	Austria	Australia and New Zealand	Finland
Centre	Single	Multi-	Multi-	Multi-	Multi-	Multi-
Patients ≥80 years old	1388	6266	6935	17 126	15 640	7025
Total ICU admission	18%	13%	N/A	13%	13%	9%
Emergency admission	90%	78%	87%	81%	62%	84%
Median ICU LOS (IQR)	2 (1.1-4.2)	N/A	2 (1.2-3.4)	3 (2-6)	2.6 (1.7-4.5)	1.2 (0.8-2.9)
ICU mortality	17%	N/A	20%	20%	12%	13%
Hospital mortality	28%	35% (30-Day mortality)	32%	37%	24%	28%
Severity score	67.4* (Mean)	N/A	26.2† (Mean)	18† (Median)	13.8* (Mean)	25.4† (Mean)
SMR	0.73	N/A	0.86	1.08	1.28	N/A

Abbreviations: APACHE = Acute Physiology and Chronic Health Evaluation; ICU = intensive care unit; IQR = interquartile range; LOS = length of stay; N/A = not available; SAPS = simplified acute physiology score; SMR = standardised mortality ratio
* APACHE IV-minus-Age score
† SAPS II-minus-Age score

period of therapy is warranted.

The impact of age on mortality has been demonstrated in our study and previous studies.[3,8,18] Similar to previous studies, however, the presence of significant co-morbidities, disease severity, and use of mechanical ventilation also independently predicted mortality.[3,4,22] These findings are not surprising and indicate that the decision to refuse ICU care for those aged ≥80 years should be based not on age alone, but also on multiple factors listed in Tables 2 and 3. Co-morbidities may manifest as impaired pre-admission functional status or increment of complication rate during hospital stay. Functional status usually includes physical, cognitive, and social functioning. Impaired functioning in daily life is more prevalent in the elderly patients and independently predicts mortality.[23,24] Previous studies have also shown that elderly patients have a higher surgical complication rate and risk of nosocomial infection.[25,26] With regard to mechanical ventilation, animal study has shown that ageing increases susceptibility to injurious mechanical ventilation–induced pulmonary injury.[27] Although no human study has confirmed this finding, survival rates in patients with acute respiratory failure correlate with age and decrease with duration of mechanical ventilation.[28,29]

Post-ICU discharge mortality is determined by care in general wards and end-of-life decisions. Calculating the ratio of hospital deaths versus ICU deaths can provide some insight into this issue. A higher ratio implies that more patients die in the general ward than in the ICU. In our study, the ratio was the same across the three groups of elderly patients (1.67), indicating a similar level of care after ICU discharge. Our finding was similar to the study by Andersen and Kvåle,[19] but our ratios were lower than those in other overseas studies.[3,4,30]

Compared with other multicentre studies,[3,4,19,20,30] we admitted more patients aged ≥80 years (18% vs 9-13%) [Table 4]. The median ICU length of stay was comparable. Similar to them[4,19,30] (except Bagshaw et al's study[3]), most ICU admissions for ≥80 year olds were emergency in nature and carried a higher hospital mortality. A study conducted by Bagshaw et al[3] had a relatively higher proportion of elective cases (38%) and explains their apparently lower hospital mortality compared with others. It is difficult to compare disease severity across different studies as severity scoring systems are inconsistent. The performance of ICU for these groups of patients, however, can be assessed by the SMR that represents the ratio of observed versus expected mortality based on the severity score. An SMR of <1 indicates better-than-expected performance and >1 indicates suboptimal performance. Our SMR was slightly lower than other overseas studies and this might indicate a better outcome for those ≥80 years old. Another possible explanation for this phenomenon is that the severity scores adopted by other studies, namely SAPS II and APACHE II score, were developed in the 1990s and may not be appropriate to the modern ICU setting.[31-33]

The triage decision for ICU admission is always a difficult task for the critical care physician. The potential benefit of ICU care should be weighed against the multiple risks, namely iatrogenic complications from invasive monitoring and treatments, higher exposure to nosocomial infection and ICU delirium, in which the elderly patients are more vulnerable.[34-36] We do not have any data from a randomised controlled trial that can advise whether we should place an upper age limit on ICU admission. Our study showed that more than 70% of critically ill patients aged ≥80 years could be discharged home and their 180-day survival rate was >60%. This is firm evidence to support ICU admission for those ≥80 years old. Post-discharge functional outcome is another valuable parameter and warrants consideration during triage decision. Such information, however, was not available in our study. The decision to discharge patients from ICU and hospital depends not only on clinical factors, but also on operational factors (eg bed occupancy and manpower issue). This may induce bias in assessment of patient outcome when using ICU or hospital mortality alone. Using 180-day mortality, as in our study, will resolve this problem.

Is it cost-effective to treat elderly patients in the ICU? It is difficult to conduct randomised study of this issue because of ethical considerations. An observational study by Edbrooke et al[37] examined the cost-effectiveness of ICU admission by comparing patients who were accepted into ICU after ICU triage with those who were not, while attempting to adjust such comparison for confounding factors. Their study showed that ICU admission not only improved survival, but the cost per life saved decreased as severity of illness increased. The cost decreased substantially for patients with predicted mortality higher than 40%. The elderly patients have significant co-morbidities and higher disease severity that contributed to elevated predicted hospital mortality. Therefore, they may benefit more from ICU care at a lower cost. Chelluri et al[38] investigated the relationship between age and hospital cost for those patients who received prolonged mechanical ventilation. Daily and total costs for hospitalisation were less for older patients than younger patients. One would think that the lower hospital cost was due to higher mortality and consequent shorter length of stay of elderly patients, but it is not the case. The relationship between age and costs was independent of hospital mortality, resuscitation status, and discharge location. More studies are required to clarify the potential health economic impact associated with increased ICU admission for these elderly patients.

Our study has several limitations. First, we have no information about the decision to limit or withdraw therapy. This may contribute to some of the differences between the oldest-old and other groups of patients. Second, the pre-ICU admission functional statuses and post-discharge quality-of-life assessment were not available. Functional status before ICU admission correlates with long-term outcome, and the absence of such information may have induced bias in this study.[7,39] Many elderly patients deteriorate with critical illness that requires ICU care and improve after hospital discharge, although quality of life fails to return to the pre-admission level even after a prolonged period.[40,41] Therefore, quality of life should be assigned the same weighting as mortality when determining a patient's outcome. Third, other confounders such as smoking or nutritional status were not recorded and might have affected prognosis. Fourth, the follow-up duration was short and long-term outcome could not be assessed. Finally, this was a single-centre study and the findings may not be applicable to other institutions.

Conclusions

The proportion of critically ill patients aged ≥80 years increased over 5 years. Age, disease severity, and presence of co-morbidities independently predicted 180-day mortality. Despite having more significant co-morbidities, greater disease severity, and higher ICU/hospital/180-day mortality rate than those aged 60 to 79 years, 71.8% of those aged ≥80 years could be discharged home and 62.2% survived >180 days from ICU admission. This provides evidence to support ICU admission for those aged ≥80 years. We recommend further studies to explore the long-term functional outcome of these critically ill elderly patients and the potential health economic impact associated with increased ICU admission for those aged ≥80 years.

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