KJCCM
Korean J Crit Care Med
2016 February 31(1):25-33 / http://dx.doi.org/10.4266/kjccm.2016.31.1.25
ISSN 2383-4870 (Print) · ISSN 2383-4889 (Online)

■ Original Article ■

Trends in the Use of Intensive Care by Very Elderly Patients and Their Clinical Course in a Single Tertiary Hospital in Korea

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Background: The number of elderly patients admitted to intensive care units (ICUs) is growing with the increasing proportion of elderly persons in the Korean general population. It is often difficult to make decisions about ICU care for elderly patients, especially when they are in their 90s. Data regarding the proportion of elderly patients in their 90s along with their clinical characteristics in ICU are scarce.

Methods: The records of Korean patients ≥ 90 years old who were admitted to the medical ICU in a tertiary referral hospital between January 2005 and December 2014 were retrospectively reviewed. We compared the trend in ICU use and characteristics of these elderly patients between 2005-2009 and 2010-2014.

Results: Among 6,186 referred patients, 55 aged ≥ 90 years were admitted to the medical ICU from 2005 to 2014. About 58.2% of these patients were male, and their mean age was 92.7 years. Their median Charlson comorbidity index score was 2 (IQR 1-3) and their mean APACHE II score was 25.0 (IQR 19.0-34.0). The most common reason for ICU care was acute respiratory failure. There were no differences in the survival rates between the earlier and more recent cohorts. However, after excluding patients who had specified "do not resuscitate" (DNR), the more recent group showed a significantly higher survival rate (53.8% mortality for the earlier group and 0% mortality for the recent group). Among the survivors, over half were discharged to their homes. More patients in the recent cohort (n=26 [78.8%]) specified DNR than in the earlier cohort (n=7 [35.0%], p=0.004). The number and proportion of patients ≥ 90 years old among patients using ICU during the 2005-2014 study period did not differ.

Conclusions: The use of ICU care by elderly patients ≥ 90 years old was consistent from 2005-2014. The overall mortality rate tended to decrease, but this was not statistically significant. However, the proportion of patients specifying DNR was higher among more recent patients, and the recent group showed an even better survivorship after sensitivity analysis excluded patients specifying DNR.

Key Words: elderly patients; intensive care; trend.

Introduction

Because people are increasingly living to an advanced age, often with chronic and degenerative diseases, the likelihood of having to make a decision about receiving critical care or facing death in hospital is increasing. The number of elderly patients admitted to intensive care units (ICUs) has also increased during the past decade,[1-3] and this has also been observed in Asia, including Korea.[4,5] The decision for intensive care, especially for elderly patients (≥ 90 years old) is important for the quality of life for patients and their families

Received on December 9, 2015 Revised on January 23, 2016
Accepted on February 19, 2016

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*No potential conflict of interest relevant to this article was reported.

and for cost-effectiveness for society.

Age is an important factor in predicting clinical outcomes of ICU care. However, age_alone is an unreliable predictor of outcomes and may be a physiological self-selector.[6-8] Considering both age and complex circumstances including reversibility and the desire of patients for end of life care affects the decision making of ICU care, especially for very elderly patients.

An Australian study shows a significant decline in-hospital mortality rates for elderly ICU patients aged > 80 years during the 10 years since 2000, with an increase in the proportion of elderly patients using ICUs.[9] However, this result included postoperative care, and information about patients ≥ 90 years old is not specified. Other studies investigating the outcome of ICU use by elderly patients defined the elderly as > 80 years old.[10,11] One study investigated ICU care in patients ≥ 90 years old including limited duration or only focusing on factors influencing mortality.[12] There were few data focusing solely on medical ICU patients.

The purpose of this study was to identify temporal trends in ICU admission and to compare the use of resources and the characteristics of critically ill patients aged ≥ 90 years admitted to a medical ICU between an earlier and more recent–year admission period in a tertiary referral hospital.

Materials and Methods

The electronic medical records (EMRs) of patients ≥ 90 years who were admitted to the medical ICU (MICU) at Seoul National University Hospital for any reason from January 2005 to December 2014 were reviewed. We excluded patients admitted to the ICU for non-medical reasons (e.g. postoperative observation). The study design and methods were approved by the Institutional Review Board of Seoul National University Hospital (IRB No. H-1510-031-710). Informed consent was waived because of the retrospective design of the study.

This retrospective chart review was based on the medical records at admission (recorded by nurses and physicians) and the notes regarding the daily progression of patients. Data regarding the cultural and social characteristics of patients were collected by reviewing the medical records complied by the nurses at admission. In general, attending nurses on wards interview all patients and/or their family members on admission. The patient and/or their family members are asked about the patient's religion, marital status, education attainment, employment status, and since January 2010 self-reported financial status (low, middle or high). In addition to this information, a family pedigree was also obtained. Other records in the wards or ICU were retrospectively reviewed in addition to EMRs.

We also collected the information about "do not resuscitate" (DNR) requests. In the earlier 5-year admission period (from January 2005 to December 2009), we were able to obtain this information from scanning paper records for DNR specific entries. These contained limited information about date, yes/no, and identification of signatory. During the more recent 5-year admission period, DNR requests were recorded electronically using an icon The DNR consent form is three pages long, and covers various end-of-life issues such as intubation, dialysis, use of vasopressors, cardiac compression, blood product support, and antibiotics use. If the families of patients make the decisions regarding DNR orders, another requirement is that they explain why surrogate decision making was necessary. There are multiple signature boxes in the consent form and all the family members participating in the discussions regarding DNR are asked to sign. If the number of participants in the family meeting was not documented, the number of signatures in the DNR consent form was considered as number of participants in the family discussions.

The aim of this study was to find a trend during the study period in MICU use by patients aged ≥ 90 years. We searched for a trend in the proportion of these elderly patients among all ICU patients and during the study period. We examined their mortality according to study period. We sought to determine the rate of DNR requests by elderly patients, which could have influenced their use of intensive care. To identify the trends in ICU use by elderly patients ≥ 90 years old, they were divided into two groups; the earlier 5 year admission group (from January 2005 to December 2009) and the more recent 5 year admission group (from January 2010 to December 2014).

Between-group comparisons were performed using a Mann-Whitney test, or a Student's t-test for continuous variables, and a chi-square test for categorical variables. A two-tailed p-value of less than 0.05 was considered to indicate

Table 1. Baseline characteristics of patients aged over 90 who admitted to medical ICU (2005-2009 vs. 2010-2014)

	2005-2014 (N = 55)	2005-2009 (N = 20)	2010-2014 (N = 35)	p-value
Age, mean (SD)	92.7 (2.4)	93.2 (2.5)	92.5 (2.4)	0.28
Male, n (%)	32 (58.2)	10 (50.0)	22 (62.9)	0.35
BMI, kg/m^2, mean (SD)	20.3 (3.6)	20.6 (3.8)	19.7 (3.3)	0.39
Education attainment, n (%)				
0-6 years	17/54 (31.5)	5/19 (26.3)	12/35 (34.3)	0.55
7-11 years	14/54 (25.9)	4/19 (21.1)	10/35 (28.6)	
≥12 years	23/54 (42.6)	10/19 (52.6)	13/35 (37.1)	
Religions, n (%)	34 (61.8)	15 (75.0)	19 (54.3)	0.13
Self-reported economic status, n (%)				
High class	7/18 (38.9)	-	7/18 (38.9)	N/A
Middle class	9/18 (50.0)	-	9/18 (50.0)	
Low class	2/18 (11.1)	-	2/18 (11.1)	
Comorbidities				
Heart diseases†	27 (49.1)	7 (35.0)	20 (57.1)	0.11
Hypertension	23 (41.8)	5 (25.0)	18 (51.4)	0.06
Cerebrovascular disease	12 (21.8)	4 (20.0)	8 (22.9)	0.81
Diabetes mellitus	15 (27.3)	6 (30.0)	9 (25.7)	0.73
Chronic lung diseases‡	14 (25.5)	6 (30.0)	8 (22.9)	0.56
Chronic obstructive lung disease (COPD)	10 (18.2)	4 (20.0)	6 (17.1)	0.79
Asthma	3 (5.5)	2 (10.0)	1 (2.9)	0.26
Interstitial lung disease	1 (1.8)	0 (0.0)	1 (2.9)	N/A
End stage renal disease	14 (25.5)	4 (20.0)	10 (28.6)	0.48
Cancer	8 (14.5)	2 (10.0)	6 (17.1)	0.47
Tuberculosis	6 (10.9)	3 (15.0)	3 (8.6)	0.46
Liver disease	5 (9.1)	2 (10.0)	3 (8.6)	0.86
Charlson comorbidity index, median (IQR)	2.0 (1.0-3.0)	2.0 (1.0-2.0)	2.0 (1.0-3.0)	0.27
APACHE II*, mean (SD), median (IQR)	25.0 (19.0-34.0)	25.0 (20.0-32.0)	27.0 (19.0-35.0)	0.56
Reason for ICU admission				
Acute respiratory failure	44 (80.0)	18 (90.0)	26 (74.3)	0.16
Cardiogenic shock	15 (27.3)	2 (10.0)	13 (37.1)	0.03
Sepsis or septic shock	3 (5.5)	1 (5.0)	2 (5.7)	0.91
In-hospital cardiopulmonary arrest	3 (5.5)	0 (0)	3 (8.6)	0.18
Metabolic acidosis	2 (3.6)	1 (5.0)	1 (2.9)	0.68
Cerebrovascular disease	2 (3.6)	0 (0)	2 (5.7)	0.28
Bleeding	1 (1.8)	1 (5.0)	0 (0)	0.18
Family members, mean (SD)				
Number of offspring	4.2 (2.0)	4.38 (1.6)	4.2 (2.1)	0.74
Number of sons	2.1 (1.5)	2.7 (1.8)	1.8 (1.2)	0.04
Number of daughters	2.1 (1.6)	1.7 (1.0)	2.4 (1.8)	0.15
Number of family members	4.9 (2.0)	4.9 (1.7)	4.8 (2.2)	0.86

*at ICU admission.

†Chronic heart disease = congestive heart failure + coronary artery disease. ‡Chronic lung disease = asthma + copd + interstitial lung disease.

ICU: intensive care unit; SD: standard deviation; COPD: chronic obstructive pulmonary disease; IQR: interquartile range; APACHE: acute physiology and chronic health evaluation.

http://dx.doi.org/10.4266/kjccm.2016.31.1.25

statistical significance. The software package SPSS Statistics for Windows, version 20.0 (SPSS Inc., Armonk, NY, USA) was used for data analysis.

Results

Among the 6,186 patients admitted to the MICU during the 10-year study period (January 2004-December 2014), 55 patients ≥ 90 years old were included. For comparison of earlier and more recent characteristics, there was an earlier 5-year admission cohort (n = 20, from January 2005 to December 2009) and a more recent 5-year admission cohort (n = 35, from January 2010 to December 2014). The baseline characteristics of the patients in each group are shown in Table 1.

Male patients were predominant (n = 32, 58.2%) and the mean age (± standard deviation) was 92.7(± 2.4) years. There were no differences in sex, age, and comorbid diseases between the earlier and more recent group. The seriousness of the underlying diseases measured using the Charlson comorbidity index score was not significantly different between the two groups. The acute physiology and chronic health evaluation (APACHE) II score was also similar between two groups, and was relatively high (median 25.0, interquartile range 19.0-34.0). The self-reported economic status information was obtained only from the more recent group because this question has only been asked since 2010. About 90% of patients described themselves as in the mid to high economic class. Other social factors such as education and religion were not significantly different between the two groups. The most common reason for ICU admission was acute respiratory failure in both the two groups.

Clinical courses of the patients have been summarized in Table 2. The median length of ICU stay was 7.0 days and that of hospital stay was 29.0 days. Duration of ICU stay

Table 2. Clinical courses of the patients aged over 90 who admitted to medical ICU between former and latter phase (2005-2009 vs 2010-2014)

	2005-2014 (N = 55)	2005-2009 (N = 20)	2010-2014 (N = 35)	p-value
Length of ICU stay, median (IQR)	7.0 (4.0-14.0)	8.0 (4.0-16.0)	7.0 (3.0-13.0)	0.67
Routes of ICU admission, n (%)				
ER	21 (38.2)	6 (30.0)	15 (42.9)	0.39
General wards	18 (32.7)	6 (30.0)	12 (34.3)	
Other types of ICU (SICU, EICU and CCU)	16 (29.1)	8 (40.0)	8 (22.9)	
Length of hospital stay (days), median (IQR)	29.0 (14.0-52.0)	35.0 (22.0-137.0)	23.0 (13.0-46.0)	0.09
Type of discharge, n (%)				
Survivors	22 (40.0)	6 (30.0)	16 (45.7)	0.25*
Discharge to home	13 (23.6)	5 (25.0)	8 (22.9)	
Discharge to other hospital	9 (16.4)	1 (5.0)	8 (22.9)	
Non-survivors (In-hospital death)	33 (60.0)	14 (70.0)	19 (54.3)	
In-ICU death	20 (36.4)	7 (35.0)	13 (37.1)	
Death in general wards	13 (23.6)	7 (35.0)	6 (17.2)	
Sensitivity analysis 1 for patients with DNR reques[†,‡]				
Survivors	15 (68.2)	6/13 (46.2)	9/9 (100.0)	0.02*,†
Non-survivors (In-hospital death)	7 (31.8)	7/13 (53.8)	0/9 (-)	
Sensitivity analysis 2 for patients with DNR reques[†,§]				
Survivors	15 (51.7)	6/17 (35.3)	9/12 (75.0)	0.04*
Non-survivors (In-hospital death)	14 (48.3)	11/17 (64.7)	3/12 (25.0)	

*p-value between survivors and non-survivors. †Calculated by Fishers' exact test. ‡Excluding all patients with DNR requests.
§Patients for sensitivity analysis 1 + Patients whose DNR requests were specified exactly before their expire.
ICU: intensive care unit, IQR: interquartile range; ER: emergency room; SICU: surgical intensive care unit; EICU: intensive care unit for emergency department; CCU: coronary care unit.

Table 3. DNR orders of the study population

	2005-2009 (N = 20)	2010-2014 (N = 35)	p-value
Reception of DNR orders, n (%)	7 (35.0)	26 (78.8)	0.004
Timing of DNR decisions, n (%)			
Before ICU admission	0 (-)	1 (3.8)	0.62
During ICU admission	3 (42.9)	15 (57.7)	
After ICU discharge to General ward	4 (57.1)	10 (38.5)	
DNR specifics, n (%)			
Do not perform chest compressions	-	21/21 (100.0)	N/A
Do not perform laboratory tests	-	4/21 (19.0)	
No dialysis	-	14/21 (66.7)	
No mechanical ventilation	-	11/21 (52.4)	
Participants in DNR decision, n (%)			
Patient	0/7 (-)	1/24 (4.2)	0.63
Spouse	0/7 (-)	2/24 (8.3)	
Offspring	7/7 (100.0)	19/24 (79.2)	
Other family members	0/7 (-)	2/24 (8.3)	
Number of participants in decision making, means (SD)	1.9 (1.46)	1.5 (0.59)	0.39

DNR: do not resuscitate, ICU: intensive care unit, SD: standard deviation.

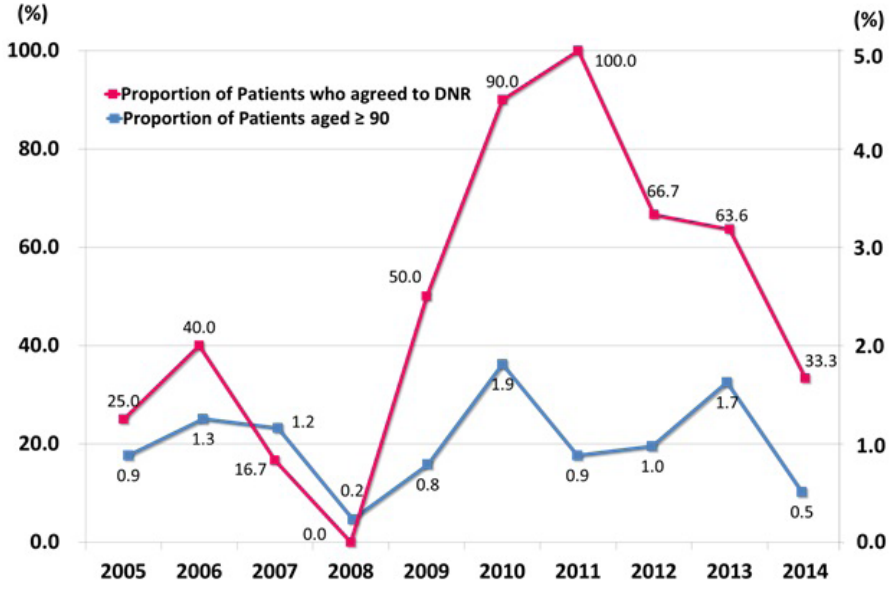

Fig. 1. The proportion of patients who were aged ≥ 90 years among whole patients during study period and that of the patients who agreed to DNR among them. DNR: do not resuscitate.

and overall hospitalization were not significantly different between groups. Although there was a tendency for a lower rate of in-hospital mortality in the more recent group, the difference between cohorts was not significant (70.0% of earlier cohort and 54.3% of the more recent cohort, respectively). About 40% of patients with ≥ 90 years old were discharged from the ICU and survival status was not significantly different between the two groups. However, after excluding patients who had submitted a DNR request, the more recent cohort showed a significantly higher survivor rate (53.8% mortality for the earlier cohort and 0% mortality for the more recent cohort, respectively). Even after ex-

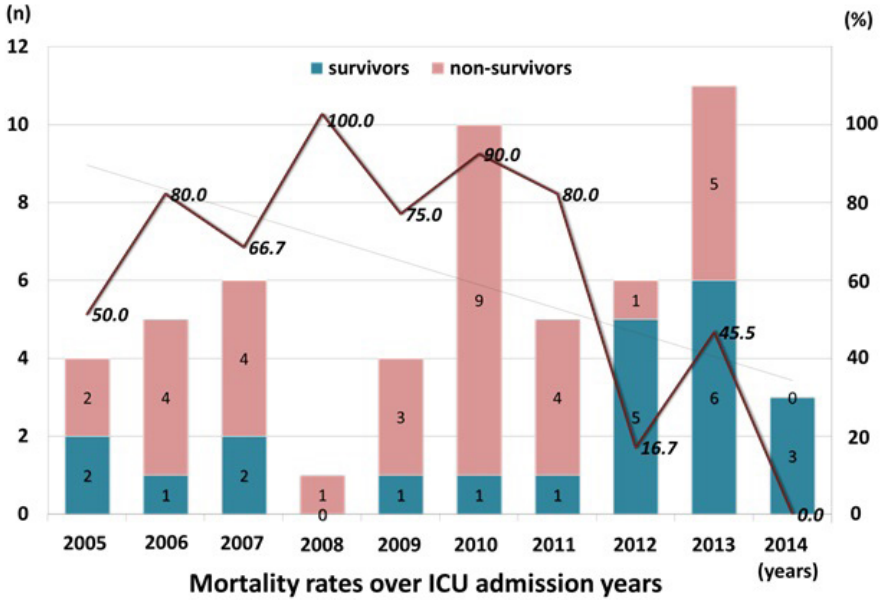

Fig. 2. Mortality rates over years of ICU admission among study population (patients aged ≥ 90 years). ICU: intensive care unit.

cluding 7 patients who agreed to DNR exactly before death in ICU (n = 4 in 2005-2009 and n = 3 in 2010-2014) more, the result was still consistent of significance (p = 0.04).

As shown in Table 3, over half of the patients specified DNR after ICU admission. The request rate for DNR was the more recent cohort (n = 26, 78.8%) than in the earlier cohort (n = 7 [35.0%], p = 0.004).

The DNR consent form included questions as to whether or not the patients wished to receive cardiac compression, and there were only screened paper records for the earlier group (2005-2009). Since 2010, the DNR consent form used in our institution has been captured in electronic form and includes information on whether the patient requested any of the following: chest compressions, ICU care, laboratory tests, dialysis, and mechanical ventilation. When interpreting a comparison of DNR requests between earlier and recent groups, this background should be recognized. The number of participants involved in the decision making process regarding DNR orders in the earlier cohort was similar to that in the recent group (1.9 and 1.5, respectively; p = 0.39). Moreover, the most frequent participants in DNR decision-making process in both groups were patients' offspring.

There was no significant trend in ICU use by patients > 90 years old according to year (Fig. 1). The in-hospital mortality rate was higher in elderly patients aged ≥ 90 years with borderline significance (data not shown). Clinical features of patients according to admission year were examined (data not shown). Among these, the in-hospital mortality rate seems to have fallen below 50% more recently (2012-2014). Figure 2 shows a decline in in-hospital mortality during these years.

Discussion

The proportion of the population ≥ 90 years old is growing rapidly in many parts of the world, including Korea, and as a result, the number of elderly people requiring intensive care is also growing.[1-5] This study aimed to investigate the trend in ICU use by patients ≥ 90 years old and compare an earlier 5-year cohort with a more recent 5-year cohort in a single tertiary hospital.

Several studies had been showed that age is not only factor influencing ICU outcome. [13,14] However, it is commonly accepted that the proportion of people ≥ 90 years old receiving ICU care is too high when comparing the benefits of ICU care with the potential harm and/or costs, suggesting that it might be more appropriate to avoid the use of ICUs for these patients. Understanding the characteristics and trends of patients ≥ 90 years old is important for physicians making a decision on whether to provide intensive care. [5,8,12] The number of patients ≥ 90 years old who use intensive care has been increasing.[5] However, there were no

differences in terms of the proportion of patients ≥ 90 years old among all patients who were admitted to the MICU during the 10-year period studied here. According to statistics compiled in Korea, a life expectancy of 80 years has increased from 0.8% of the total population in 1994 to an expected figure of 6.4% in 2034.[4] In addition, it's more important that this discrepancy, which is expected to increase, might reflect the absence of a definite rule or rationale to determine the use of intensive care in elderly patients.

There was no difference in social factors such as education attainment or having religious faith. The information regarding economic status was limited to patients in the more recent cohort, and the self-assessment was generally in middle or high economic status. Further studies about social factors influencing the use of ICUs by elderly patients are needed to clarify the influence of socioeconomic status variables.

The APACHE score of the patients was relatively high, but significantly not different between the groups. The APACHE score was 25 compared with earlier studies that found scores ranging from 14 to 20.[5,15] This may be the result of different inclusion criteria, which were based on those of the tertiary referral hospital in all studies, but included both medical and surgical ICUs with postoperative patients in other studies, which led to the inclusion of patients who were less critically ill. In-hospital mortality in the present study was 60% during the 10-year study period, which was also relatively high compared with previous studies including less critically ill patients.[5] Higher in-hospital mortality could be explained by higher disease severity and higher burden of disease in the present study. Along with this high in-hospital mortality, the growth in the discussion of DNR in clinical fields is worthy of further investigation. After a sensitivity analysis for patients without a DNR request, lower mortality was prominent in more recent group, along with a relatively increased tendency for DNR requests. Another sensitivity analysis also showed significantly lower mortality rate in more recent group when seven patients those who accepted DNR just before they passed away (mostly by their families) were specified from the patients with DNR requests.

The only index that was significantly difference between the earlier and the later cohorts was the presence of DNR documentation, which was higher in the more recent group. This finding has rarely been discussed in previous studies. In addition, the identity and number of participants in the DNR decision have rarely been reported in other studies. Nevertheless, our finding is that active discussion among physicians, patients and their families has become widely accepted. Previous data showed that DNR requests were documented for 73.5% of patients who died in an MICU in Korea.[16] Compared with those findings, all the patients who died in the MICU in more recent cohort in the current study had a DNR request. The increase in the recognition of DNR along with specification of DNR form is highly desirable in critical and end-of-life care of elderly patients.

No difference in the length of hospital stay and in-hospital mortality was observed in relation to existence or otherwise of a DNR request. Previous studies showed that there is no difference in the length of hospital stay regardless of the existence of a DNR request. [17,18] However, this study was limited to the use of an MICU compared with previous studies that included surgical ICUs or mixed ICUs. The rate of DNR requests was higher in the more recent group; however, most of the requests were received after ICU referral, which meant that physicians did not have any opportunity for triage based on the patients' wishes. Because most studies regarding DNR requests in relation to ICU patients were conducted after ICU admission, the exact proportion of DNR requests made before ICU admission was hardly to be found. [16-19] The accuracy of the DNR documentation was less comprehensive in the earlier group, when verbal DNR requests were preferred, resulting in a lower precision of documentation. To enhance the application of patients' decisions regarding their end-of-life care, the discussion about DNR requests should be held before any event necessitating ICU referral, despite the obvious limitations.

In-hospital mortality was consistently > 50% during the study period, except for the most recent 3 years during which it fell to below 50% (with no deaths in 2014). Further studies investigating in-hospital mortality and factors related to mortality are warranted. Clinical outcomes from long-term observations are also needed to identify future trends. Despite the high APACHE scores of the patients in this study, in-hospital mortality was nevertheless relatively high in the very elderly patients in this study. [20]

This study had some limitations. It was conducted in a single center, and the results may not be applicable to all

elderly patients. However, the study population was based on patients who were admitted to the representative tertiary hospital in Korea during a 10-year period, and more than 6,000 patients who visited the hospital during the study period were considered for the study. Second, other possible factors influencing the health status of patients, including nutrition, were not investigated. Third, we could not perform a longitudinal analysis to predict ICU use or in-hospital mortality. Despite these limitations, the findings of this study might be helpful for the care of elderly patients which is complex because of various medical and social circumstances. We recommend that physicians consider the results of this study when they meet an acute situation requiring ICU admission of an elderly patient.

This study showed that the use of ICU by patients aged ≥ 90 years was similar throughout the 10-year study period. Patients aged ≥ 90 years in this study have generally used MICUs for acute respiratory failure most commonly. Because of the high APACHE scores of the participants in this study and their high in-hospital mortality, studies about the growth in discussions about DNR requests in clinical fields and their effects including patients' satisfaction and that of their families' are warranted.

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