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Equity of access to critical care among elderly patients in Scotland: a national cohort study

Annemarie B. Docherty^{1,2} MPH, Niall H. Anderson¹ PhD, Timothy S. Walsh^{1,2} MD, Nazir I. Lone^{1,2} PhD.

1. University of Edinburgh, 2. Royal Infirmary Edinburgh

Corresponding and requests for reprints should be addressed to: Annemarie Docherty, Department of Critical Care, Royal Infirmary Edinburgh, Little France Crescent, Edinburgh, EH16 4SA, email: annemarie.docherty@ed.ac.uk

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ABSTRACT:

Objective: To compare “elderly” (≥ 80 yrs), “older” (65-79) and “younger” (< 65 yrs) ICU admissions in Scotland in relation to: trends in admission rates; regional variation in admissions; ICU treatment intensity; and ICU and one year mortality.

Design: National five year cohort study of ICU first admissions (01/01/2005-31/12/2009).

Setting: All admissions to ICUs and combined units (Level 2/3 care) in Scotland captured by the Scottish Intensive Care Society Audit Group database, linked with hospital discharge data and death records.

Patients: 40,142 patients: 3,865 were ≥ 80 yrs (9.6%); 13,904 (34.6%) 65-79 yrs; and 22,373 < 65 yrs (55.6%).

Interventions: None.

Measurements and Main Results: Between 2005 and 2009, elderly admission rates decreased from 36.6 (95%CI 34.0-39.2) to 28.7 (95%CI 26.5-30.9) per 10,000 population ($P < 0.001$; relative decrease: 22.0%); older admission rates also decreased, but less steeply (31.1 (95%CI 29.9-32.2) to 26.1 (95%CI 25.1-27.1) per 10,000 population, $p < 0.001$; relative decrease 16.1%). Rates were static for younger patients. Restricted to mechanically ventilated elderly patients, rates ranged from 13.9 to 30.1/10,000 between healthboard administrative regions ($P < 0.001$). Emergency surgical diagnoses were more prevalent for elderly patients (39.8% older (25.1%) and younger cohorts (20.3%); $P < 0.001$). Subgroup analyses limited to pneumonia admissions (elderly ($n=242$), older ($n=1,226$), younger ($n=1,835$)) indicated similar acute physiology scores, but fewer pre-existing comorbidities among elderly patients ($P=0.007$), who received a shorter duration of organ support and ICU stay. Mortality rates were higher in elderly patients at ICU discharge (elderly 26.5%; older 25.0%; younger 17.0%; $p < 0.001$; confounder adjusted (adj) OR elderly vs younger 2.33 (95%CI 2.11-2.58;

p<0.001). Differences persisted at one year (elderly 52.2%; older 43.8%; younger 27.6%, adjOR elderly vs younger 3.72 (95%CI 3.42-4.06; p<0.001).

Conclusions: In Scotland, elderly and older ICU admission rates are decreasing, with regional geographical variation. Although limited by an absence of a measure of frailty, patient characteristics and treatment intensity suggest selection of less comorbid elderly patients, indicating possible rationing based on chronological age.

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INTRODUCTION

The population is ageing, and life expectancy is increasing. The number of people aged over 60 years is estimated to grow from 524 million in 2010, to over 1.5 billion by 2050 ^{1,2}. In the United Kingdom (UK), the number of people aged 85 and over is projected to be 3.6 million by 2037, 2.5 times more than in 2012 ³. Several intensive care unit (ICU) studies have demonstrated parallel increases in admission rates for elderly patients; such trends have significant implications for healthcare resource use ⁴⁻⁶.

Increasing age is associated with greater comorbidity and frailty^{7,8}. Comorbidity is associated with poorer functional status, quality of life and health outcomes, and more frequent hospital admissions⁷. Frailty is a major determinant of mortality, hospitalization, institutionalisation, and functional outcomes⁹⁻¹¹. When considering admission to ICU, clinician decision-making is a complex process, but older age and the presence of comorbidities and frailty may increase the probability that ICU admission is considered inappropriate¹²⁻¹⁶. Subjective decision-making increases the risks of inter-individual variation and inequity of access to ICU care. For example, physicians underestimate the functional status of patients rejected for ICU admission, but overestimate the status of those accepted¹⁷. Elderly patients may receive a lower intensity and duration of treatments than younger patients once admitted to ICU^{6,18-20}.

As the older population living with comorbidity grows, an improved understanding of patterns of admission of elderly patients to ICU is important to track and compare practice over time both within and between institutions. This is particularly important given that both short- and long-term mortality for elderly patients admitted to ICU are significantly higher than for younger patients^{4,6,18-22}, and long-term functional status among survivors is often significantly impaired.^{21,23-26}

Using complete, national linked health care databases for all patients aged 16yrs and over, admitted to Scottish ICUs from 2005-2009, we aimed to compare elderly (≥ 80 yrs) with younger (< 65 yrs) ICU admissions in relation to: trends in admission rates; regional variation in admissions; ICU treatment intensity; and ICU and one year mortality. We hypothesised that ICU admission rates for elderly patients would track general population demographic changes and that regional variation within Scotland, which has a national health service free to users, does not exist. To explore any variation that might exist, we also aimed to describe patterns of comorbidity, organ support provided during ICU care; and short and long-term survival for elderly patients in comparison to the younger national cohort.

MATERIALS AND METHODS

Study design and Setting

This was a retrospective cohort study using prospectively collected data from 01/01/2005 to 31/12/2009. As the study used routinely collected anonymised data, a waiver was granted by the research ethics committee.

Setting and Participants

The Scottish Intensive Care Society Audit Group (SICSAG) database contains data on every patient admitted to all adult general ICUs and combined ICU/HDUs (High Dependency Units) across Scotland (www.sicsag.scot.nhs.uk). There are no private ICU facilities for general ICU patients in the country. We restricted this dataset to include those aged ≥ 16 yrs resident in Scotland and first ICU admissions: each patient could only be represented once. The SICSAG database was linked with Scottish hospital records (SMR01), and National Records Scotland (NRS) death records. These national databases provide information for all hospital admissions in Scotland, and all deaths registered in the country. During the study

period, there were 173.4 level 2/3 beds across Scotland (range 4.0 to 34.6 between healthboards). Average bed occupancy for Scotland was 75% during 2005-2009²⁷ (range 56.6 % to 81.9% between healthboards, Table E1).

Variables

The SICSAG database contains demographic data, severity of illness data using the Acute Physiological and Chronic Health Evaluation (APACHE II) model, and daily interventions including measures of respiratory, cardiovascular, and renal support. These data, including the daily intervention data (Augmented Care Period) have been separately validated by SICSAG²⁸. Patient comorbidities were derived from the SICSAG database and Scottish hospital records. For a detailed description of variables see the electronic supplementary material.

Exposure: Elderly patients were defined as ≥ 80 yrs on the day of ICU admission. We compared this with a younger group <65 yrs. Although some previous studies used 65 years as a cut-off to define the elderly population, the average life-expectancy in Scotland is 76.5 yrs for men and 80.1 yrs for women²⁹ and we considered an older cut-off more appropriate. We also included the intermediate “older” age group (65-79 yrs) as a comparator group. This approach is consistent with previous studies^{5,30}.

Outcomes: Primary outcomes were ICU mortality and one year mortality. Secondary outcomes were treatment intensity (renal replacement therapy, cardiovascular support, number of organs supported).

Confounders: Outcomes (mortality and treatment intensity) in analyses relating to the full cohort and subgroups were adjusted for the following potential confounders: sex, socio-economic status (SES, measured using population quintiles (see electronic supplement)), presence and number of comorbidities, number of hospital admissions in the past year,

admission from non-home versus home residence and acute physiology score. Analyses relating to the full cohort were additionally adjusted for mechanical ventilation on day of admission, primary diagnosis, and type of admission.

Statistical methods

The database was cleaned, recoded and reformatted using STATA 13.0 (Statacorp, Texas, USA), then analysed using R version 3.1.1. (NY, USA).

Comparison was between the elderly group (≥ 80 years) and the reference younger group (< 65 years). Normally distributed variables were compared using the t-test, non-normally distributed variables using the Kruskal Rank Sum test, categorical variables were compared with the χ^2 test, and ordinal variables compared with the χ^2 test-for-trend. Statistical significance was taken as $p < 0.05$. All significance tests were two tailed. 95% confidence intervals (CI) were presented where appropriate. Continuous variables were described using mean and standard deviation (SD) or median and interquartile range (IQR, first and third quartiles). Categorical variables were presented as n(%).

Incidence of ICU admission

We calculated incidence of first admission of elderly and younger patients to ICU by year. We also performed sensitivity analyses restricted to patients who were mechanically ventilated on the first day of admission to reduce the impact of service reorganisation. We compared incidence of admission by local health administrative region (healthboard) of residence using combined data for the entire 2005-2009 period to increase numbers. We restricted this analysis to elderly patients who were mechanically ventilated on the first day of admission to minimise confounding from population heterogeneity attributable to service organisation. We used Poisson regression to test for the variation in incidence rates.

ICU treatment intensity

Comparison of ICU treatment intensity (proportion receiving organ support, number of organs supported and length of organ support/ICU stay) between age groups was potentially subject to confounding by differences in the patient diagnoses in the comparator groups. We therefore used a number of approaches to minimise confounding: 1) we restricted our analyses to two homogeneous subgroups defined by ICU admission diagnostic category: a prevalent medical diagnosis (pneumonia) and a prevalent surgical diagnosis (emergency abdominal surgery); 2) We adjusted proportion receiving organ support for potential confounders using binary logistic regression; 3) we only included patients who received mechanical ventilation on the day of admission, again to minimise confounding from population heterogeneity and to restrict comparison to the most severely ill group; 4) we performed a subgroup analysis restricting the cohort to patients without recorded comorbidities.

Mortality

Binary logistic regression was used to adjust ICU and 12 month mortality outcomes between the three age categories for potential confounders. Further details of statistical analyses are provided in electronic supplementary material.

RESULTS

Between 2005 and 2009 there were 40,142 first admissions of patients aged 16 years or over to ICUs in Scotland (Figure E1: Consort diagram). Elderly patients comprised 9.6% of admissions, older patients 34.6%, and younger patients 55.6%. Males and patients from lower socioeconomic backgrounds (SES) were over-represented relative to the general population.

Elderly patients had a higher prevalence of comorbidities compared with the younger groups (11.4% vs 13.1% (older) vs 9.7% (younger) ≥ 2 comorbidities, χ^2 test-for-trend $p < 0.001$) (Table 1, Table E2). 93.2% of elderly patients were living at home prior to their ICU admission. Overall, the elderly and younger groups had similar APSs during the first 24 hours in ICU (median APS 14 vs 14, $p = 0.386$). 55.0% of the elderly group received mechanical ventilation compared with 60.5% of the older group, and 65.2% of the younger group (Table E3). Admission type was different between age categories ($p < 0.001$). The proportion of patients admitted after emergency surgery was higher with increasing age category (younger 20.3%; older 25.1%; elderly 39.8%); fewer elderly patients were admitted with non-operative conditions (elderly 42.4%; older 53.2; younger 66.6%).

Incidence of ICU admission

The elderly population of Scotland increased from 207,583 (4.1%) in 2005 to 224,272 (4.3%) in 2009 (relative increase: 8.0%). Over the same period, there was a small but significant decrease in admissions to ICU of elderly patients both as a proportion of ICU admissions (10.0% to 8.4%; χ^2 test-for-trend $p < 0.001$) and as an incidence per 10,000 elderly population (crude ICU admission incidence 36.9/10,000 in 2005 to 28.8/10,000 in 2009, p value < 0.001 ; relative decrease: 22.0%). Direct standardisation for sex and SES did not substantially change estimates (36.6/10,000 in 2005 to 28.7/10,000 in 2009, $p < 0.001$) (Figure 1). There was also a less steep, but still significant decrease in admissions to ICU of the older group over this time (crude ICU admission 31.1/10,000 in 2005 to 26.1/10,000 in 2009, $p < 0.001$; relative decrease 16.1%). These admissions trends persisted when restricting the analyses to patients who received mechanical ventilation on the day of admission (elderly: 21.0/10,000 in 2005 to 16.8/10,000 in 2009; older 19.8/10,000 to 16.7/10,000).

After standardisation for sex and SES, and using the numbers of the elderly population in each region as the denominator, there was evidence of regional variation in ICU admission rate for elderly patients who received mechanical ventilation on the day of ICU admission (range 13.9/10,000 to 30.1/10,000, χ^2 92.2, $p < 0.001$) (Figure E2).

ICU treatment intensity

Pneumonia: There were 2,868 patients admitted with pneumonia during the five year study period, of whom 69.9% (n=346) of the elderly, 77.4% (n=1584) of the older group and 72.7% (n=2,522) of younger groups were ventilated on the first admission day (Table 2). Ventilated age groups had similar APS scores (elderly: median 17 (IQR 13,22), older 16 (13,20), younger 17 (13,21), $p=0.140$). The older group had the most comorbidities (≥ 1 comorbidities 39.9%), and elderly patients had the fewest comorbidities (≥ 1 24.3%, $p=0.001$). Elderly patients were more likely to receive cardiovascular support but less likely to receive renal replacement therapy; this difference persisted after adjustment for confounders (Table 2). Elderly patients received a shorter duration of ventilation and ICU stay; this difference persisted when limited to ICU survivors. For patients who survived to ICU discharge, differences in duration of cardiovascular or renal support were not significant. Elderly patients who died in ICU had significantly shorter periods of mechanical ventilation, renal replacement therapy and ICU length of stay than younger patients (Table 2).

Emergency abdominal surgery: There were 9,315 patients admitted after emergency abdominal surgery during the five year study period (Table 3). Of these 54.7% (n=833) of the elderly, 54.7% (n=3958) of the older patients, and 52.4% (n=2008) of the younger patients were ventilated on the first admission day. Findings were broadly similar to the pneumonia sub-group: elderly patients had fewer comorbidities, received more cardiovascular support, and less renal replacement therapy (Table 3). In contrast to the pneumonia sub-group, the

duration of renal support and cardiovascular support were shorter in elderly vs younger patients, and the duration of mechanical ventilation and ICU stay were similar to the younger patients. Elderly non-survivors had a shorter duration of mechanical ventilation, cardiovascular support and a trend towards a shorter ICU length of stay (Table 3).

Subgroup analyses restricting the cohort to those with no recorded comorbidity confirmed the findings of the main analyses for both patients with pneumonia and emergency abdominal surgery (table E4).

Mortality and discharge disposition

Short-term: Overall ICU mortality in the elderly was significantly higher than in the younger group in the whole cohort (26.5% vs 17.0%, $p < 0.001$), even after adjustment for potentially confounding variables (adjusted (adj) OR 2.33, 95% CI 2.11-2.58; Table 4). On discharge from hospital fewer elderly survivors returned home (elderly 82.1%; older 90.5%; younger 92.1%; $p < 0.001$) (Table 5).

12 month mortality: The mortality rate for the elderly group remained approximately double the rate of the younger group during the first year (52.2% vs 27.6%, adjOR 4.93, 95%CI 4.49-5.43, $p < 0.001$, Figure 3, Table 3). Elderly patients admitted with a non-operative diagnosis had the highest mortality rate (42.2%). However, on a relative scale, there was a similar two-fold increase in mortality for each admission type (Figure 2).

Subgroup analyses confirmed higher mortality rates in elderly compared with younger groups after confounder adjustment (Table 2): pneumonia subgroup: adjOR 4.87 (95% CI 3.52-6.82); emergency abdominal surgery: adjOR 4.25 (95% CI 3.50-5.17).

DISCUSSION

We hypothesised that ICU admission rates for elderly patients should track general population demographic changes if admission practices were consistent over time, but found that crude and standardised annual admission incidence decreased significantly between 2005 and 2009. These trends were present in all sensitivity analyses, which included standardisation for age and SES, and restriction to patients who were mechanically ventilated on the day of admission. There was also a significant, but less steep decline in admissions of the older (65-79yr) group over this time. We believe this finding is a real reflection of the incidence of ICU admission of the elderly in Scotland over this time, and is unlikely to be explained by service reconfiguration or other confounders. Large differences also existed between healthboards, despite allowing for potential confounders. It is possible that variation is explained in part by residual confounding; for example SES is a crude measure of comorbidity and it may be that standardisation did not fully account for differences in comorbidity burden or other aspects of case mix. However, our results are consistent with an unexpected downward trend in admission rates for elderly patients, and variation in practice within Scotland. This could indicate trends towards reduced access to critical care for the elderly over time, and variation between different parts of the country.

Approximately two thirds of elderly patients had no comorbidities, a similar proportion to the younger group, despite the known association between increasing age and comorbidity^{7,8}. In the pneumonia and emergency abdominal surgery subgroups, elderly patients actually had fewer comorbidities compared with the two younger groups. This suggests that clinical decision-making at the time of ICU admission was influenced by the presence of chronic disease among elderly patients. The observation of an underrepresentation of those from lower socioeconomic backgrounds in the elderly cohort was also consistent with this finding, because this is associated with greater comorbidity⁷. Although we have no data describing patients referred but not admitted to ICU, the variation between regions raises the possibility

of important differences in decision-making and access to care. A wide range of factors could contribute to this, including bed-pressures and systematic differences in local practice. Our data demonstrate the importance of understanding variation in practice to ensure equity across the health system. Further work is needed to explore sources of variation, for example using surveys or qualitative methods.

In relation to organ support, we expected that rates and duration of organ support in elderly patients would be similar to, or exceed, rates in the younger cohort based on the association between increasing age and lower physiological reserve. This was the case for the middle “older” group, when compared with the younger group, but not in the elderly group, which supports possible rationing in this cohort. For mechanical ventilation, rates in Scotland were significantly higher for all age categories than reported in other literature^{4,5,19,20}; this reflects the relatively low number of ICU beds/population in Scotland (and the wider UK)^{31,32}. In our study, 10% fewer of the elderly population received mechanical ventilation compared with the younger group. It is difficult to establish the relationship between the decision to provide mechanical ventilation and pre-existing comorbidity from the whole cohort analysis, given the wide case-mix. However, in the analyses restricted to pneumonia and emergency abdominal surgery the lower prevalence of comorbidity in the elderly cohort further suggests this may influence the decision to provide ventilator support in elderly compared with younger patients. Among the mechanically ventilated cohorts, elderly patients received greater organ support overall mainly as a result of greater cardiovascular support. It is unlikely that mechanical ventilation is initiated without the intention to provide inotropic and/or vasopressor support when required, and the higher rates of support may reflect the lower cardiovascular reserve of elderly patients. Our dataset did not include information about acute kidney injury, and data were restricted to the provision of renal replacement therapy. We found elderly patients received less renal replacement therapy despite being

more prone to developing acute kidney injury during critical illness³³. This may reflect limitations to treatment, but could also be explained by the selection of patients with lower comorbidity who are at lower risk of acute kidney injury.

Overall, the elderly received a shorter duration of organ support and shorter ICU stay. This was only partly accounted for by higher mortality rates in the elderly group. This finding is surprising, as in the presence of reduced physiological reserve recovery from an acute insult would be expected to be slower than for younger patients. This finding may reflect the case selection, but is potentially explained by a greater tendency for elderly patients to receive a “trial” of supportive treatment, with earlier decision-making regarding treatment limitation or withdrawal compared with the younger patients.

The crude risk of ICU and one year mortality in the elderly was higher than in the two younger age groups across all admission types, and persisted after adjustment for potential confounders. Mortality rates were particularly high in elderly patients admitted with non-operative conditions. The numbers of elderly patients admitted with emergency surgical conditions was proportionately considerably higher than for the younger age categories. The reasons for this are unclear, but it is possible that clinicians believe short and long-term outcomes from acute surgical conditions, for which post-operative ICU admission is part of a package of care, are more favourable than non-operative medical conditions. Pressures from surgical teams could also be relevant. Comparing pneumonia with emergency abdominal surgery, although crude mortality rates were higher overall for pneumonia, the incremental risk of death in hospital and at 12 months was similar for both groups compared to the younger cohort. Overall 94% of hospital survivors were discharged home or to rehabilitation suggesting a reasonable level of independence, and survival rates at 12 months were 25% and 45% of the pneumonia and emergency abdominal surgery groups respectively. Given the

advanced age of the cohort these outcomes suggest critical care was worthwhile, and further highlight the importance of ensuring equitable access.

Our data are consistent with a Canadian cohort study which found a steeper longitudinal decline in ICU admissions for patients >80 years compared with younger age groups³⁴, but are in contrast with other studies that report ICU admission rates for the elderly have increased in line with population demographic changes^{4,6}. Other studies have also found a reduction in treatment intensity for the elderly, despite matching for illness severity^{4,35,36}. A wide range of ICU and one-year mortality rates for the elderly have been reported (ICU mortality: 12.0%-37.8%²³; one-year mortality: 56.1%-85%²¹). Despite the high severity of illness scores and high proportion of mechanical ventilation in our study, the ICU and one-year mortality rates were similar or lower^{20,21,23} than previously published literature.

Discharge disposition is a crude surrogate for the level of independence attained, and was similar to previous studies in elderly cohorts in which 75%²¹ and 72%⁴ of elderly survivors were discharged home.

Our study had potential limitations. We had no access to a measure of frailty, which is particularly important in the elderly population and is not fully described by comorbidity³⁷. We had no information about clinician decision-making related to ICU admission, including whether decisions to limit care occurred early (such as in the emergency department) or later (discussion with the critical care specialist); we also had no information regarding subsequent treatment limitation, withdrawal or patient preferences for life-sustaining therapy. We were unable to distinguish between patients who did not receive organ support because they did not require it and those for whom escalation of treatment was considered futile. However, the comparisons of organ support stratified by survivor status assessed for indirect evidence of treatment limitation. We limited our exploration of treatment intensity to the subgroup of critically ill elderly patients in whom ICU admission *and* mechanical ventilation occurred,

which reduced confounding but decreased generalizability to non-ventilated patients. We also had no data on functional status and quality of life among survivors.

We believe our data have important implications for Scotland but also for other healthcare systems given the increasing numbers of elderly patients. Our data highlight the importance of measuring system-wide trends in access to care over time, but also variation within a healthcare system. Analyses of national data such as this provide a mechanism to trigger further exploration of sources of variation. Given the complexity of decision-making for critically ill elderly patients, where multiple factors may interplay, the potential for inequitable access within a system is high. This is particularly important given the difficulty faced by clinicians when required to accurately prognosticate for individual critically ill patients³⁸. Future studies should concentrate on decision-making before ICU, at the point of referral, and during ICU care. Furthermore, chronological age is a crude measure of physiological reserve in the elderly and work that builds on research into the importance of pre-existing comorbidities and frailty^{10,11,37,39} on short and long-term survival and quality of life in the elderly population is needed.

CONCLUSIONS

The incidence of ICU admission for elderly patients is decreasing in Scotland in contrast to changing population demographics, and significant variation between administrative healthboard regions exists. Admitted patients typically have lower comorbidity than younger patients, are more likely to have undergone surgery, and receive a shorter duration of ICU treatment. These data indicate the possibility of rationing based on chronological age, and geographical variation in access to care and illustrate the value of population-based administrative data to identify potential inequities in healthcare access.

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All authors contributed to the conception and design of the study; AD undertook the analysis; all authors contributed to interpretation of data; all authors contributed to drafting the article or revising it critically for important intellectual content; all authors gave final approval of the version to be published.

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Figure legends:

Figure 1a: Incidence of first ICU admissions per 10,000 Scottish population per calendar year. Incidence with 95% CI, stratified by age category: ≥ 80 “elderly”; 65-79 “older”; < 65 “younger”. Figure 1b: incidence of elderly, older and younger ICU admissions, restricted to patients mechanically ventilated on day 1 of ICU admission.

Figure 2: Survival during first year following ICU admission, stratified by type of admission. Figure 2a: elderly group; Figure 2b: older group; Figure 2c: younger group. El surg: Elective surgical admission, Em surg: Emergency surgical, Non Op: Non Operative

Table 1: Baseline characteristics for the whole cohort, the elderly and younger groups. APACHE: Acute Physiological and Chronic Health Evaluation. APACHE Pred Mort: APACHE predicted mortality (%). APS: Acute Physiological Score (component of APACHE). Med (IQR): Median (Interquartile Range). Categorical variables: Chi2 test/Chi2 test for trend; continuous variables: Kruskal Wallis test.

	Total	%	<65	%	65-79	%	≥80	%	p-value <65 vs ≥80
Number of admissions (n)	40142		22373	55.7	13904	34.6	3865	9.6	
Age (median,IQR)	62	(47,73)	49	(37,58)	72	(68,75)	83	(81,85)	
Male (n,%)	22192	55.3	12668	56.6	7690	55.3	1834	47.5	<0.001
SocioEconomic Status									<0.001
1 (least deprived)	5079	12.7	2630	11.8	1871	13.5	578	15	
2	6638	16.5	3456	15.8	2380	17.1	712	18.4	
3	7892	19.9	4414	19.7	2766	19.9	802	20.8	
4	9453	23.5	5478	24.5	3177	22.8	798	20.7	
5 (most deprived)	10989	27.4	6305	28.2	3710	26.7	974	25.2	
Admission from									<0.001
Private Residence	36249	90.2	19557	87.4	13089	94.1	3603	93.2	
Institution	270	0.6	138	0.6	79	0.6	53	1.4	
Other	3693	9.1	2678	12.0	736	5.3	209	5.4	
Admission type									<0.001
Elective Surgical	6587	16.4	2927	13.1	2976	21.4	684	17.7	
Emergency Surgical	9558	23.8	4534	20.3	3486	25.1	1538	39.8	
Non Operative	23921	59.6	14876	66.6	7407	53.2	1637	42.4	
Number of comorbidities n(%)									<0.001
0	26974	67.2	15915	71.1	8434	60.7	2625	67.9	
1	9284	23.1	4797	21.4	3648	26.2	839	21.7	
2	2770	6.9	1231	5.5	1257	9.0	282	7.3	
≥3	1114	2.8	430	1.9	565	4.1	119	3.1	
Severity of illness scores									
valid	35030	87.3	19859	88.8	11927	85.8	3244	83.9	
missing	5112	12.7	2514	11.2	1977	14.2	621	16.1	
APACHE II med (IQR)	18	(13,24)	16	(11,22)	21	(16,26)	20	(16,25)	<0.001
APACHE Pred Mort med (IQR)	21	(6,45)	15	(4,36)	30	(11, 53)	30	(11,52)	<0.001
APS med (IQR)	14	(9,19)	14	(9,19)	14	(10, 19)	13	(9,18)	0.386

Table 2: Subgroup: Pneumonia in patients mechanically ventilated on day of ICU admission. Med(IQR): Median(Inter Quartile Range); CV: cardiovascular support; RRT: Renal Replacement Therapy; MV: Mechanical Ventilation; LOS ICU: Length of Stay ICU. REF: Reference category for Odds Ratio. Adj OR: Adjusted Odds Ratio (adjusted for: sex, socioeconomic status, presence and number of comorbidities, number of admissions in the past year, admission from non-home residence, acute physiology score). Categorical variables: Chi2 test/Chi2 test for trend; continuous variables: Kruskal Wallis test.

	<65	65-79	≥80	p value
n	1856	1226	242	
APACHE II med (IQR)	20 (15,24)	23 (19,27)	23 (19,28)	<0.001
APS med (IQR)	17 (13, 21)	16 (13, 20)	17 (13, 22)	0.140
No. comorbidities n(%)				0.001
0	1219 (65.7)	736 (60.0)	183 (75.6)	
1	473 (25.5)	345 (28.1)	45 (18.6)	
≥2	164 (8.8)	145 (11.8)	14 (5.7)	
CV support n(%)	1249 (67.3)	892 (72.8)	186 (76.9)	<0.001
Adj OR (95% CI)	REF	1.29 (1.08, 1.54) p=0.006	1.55 (1.10, 2.23) p=0.015	
RRT n(%)	372 (20.0)	271 (22.1)	37 (15.3)	0.043
Adj OR (95% CI)	REF	1.18 (0.97, 1.44) p=0.105	0.66 (0.43, 0.97) p=0.040	
Number of organs supported n(%)				<0.001
1	581 (31.3)	311 (25.3)	55 (22.7)	
2	929 (50.1)	667 (54.4)	151 (62.4)	
3	346 (18.6)	248 (20.2)	36 (14.9)	
Duration of support				
MV med (1st,3rd,max quartiles)	7 (3, 13, 107)	6 (3,13,284)	4 (2, 9, 43)	<0.001
Survivors	7 (3, 14, 107)	7 (3,14,92)	5 (2,10,43)	0.049
Non Survivors	6 (2,13, 84)	6 (2,12,284)	4 (2,8,29)	0.008
RRT med (1st,3rd,max quartiles)	0 (0,0,39)	0 (0,0,38)	0 (0,0,23)	0.033
Survivors	0 (0,0,38)	0 (0,0,38)	0 (0,0,23)	0.438
Non survivors	0 (0,2,39)	0 (0,2,32)	0 (0,0,11)	0.004
CV support med (1st,3rd,max quartiles)	2 (0,4,70)	2 (0,4,23)	2 (1,4,16)	0.142
Survivors	1 (0,4,33)	2 (0,3,20)	1 (0,4,14)	0.830
Non survivors	0 (0,2,39)	2 (1,4,23)	0 (0,0,11)	0.550
LOS ICU med (1st,3rd,max quartiles)	8 (3,15,114)	7 (3,14,284)	5 (2,9, 46)	<0.001
Survivors	7 (3,14, 114)	9 (4,17,113)	4 (2,11, 46)	0.091
Non Survivors	5 (1,12, 82)	5 (1,11,284)	3 (1,8, 31)	0.028
Mortality				
ICU n(%)	542 (29.5)	546 (44.5)	137 (56.6)	<0.001
Adj OR (95% CI)	REF	2.06 (1.75, 2.45) p<0.001	3.66 (2.70, 4.99) p<0.001	
1 year n(%)	755 (41.1)	745 (60.7)	182 (75.2)	<0.001

Adj OR (95% CI)	REF	2.45 (2.08, 2.89) p<0.001	4.87 (3.52, 6.82) p<0.001	
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Table 3: Subgroup: Emergency Abdominal Surgery in patients mechanically ventilated on day of ICU admission. Med(IQR): Median(Inter Quartile Range); CV: cardiovascular support; RRT: Renal Replacement Therapy; MV: Mechanical Ventilation; LOS ICU: Length of Stay ICU. REF: Reference category for Odds Ratio. Adj OR: Adjusted Odds Ratio (adjusted for: sex, socioeconomic status, presence and number of comorbidities, number of admissions in the past year, admission from non-home residence, acute physiology score).

	<65	65-79	≥80	p value
n	2008	2165	833	
APACHE II med (IQR)	17 (12,23)	19 (16, 24)	21(17,26)	<0.001
APS med (IQR)	13 (9,17)	13 (10, 18)	13 (10,17)	<0.001
No. comorbidities n(%)				0.002
0	1176 (58.6)	1315 (60.7)	587 (70.5)	
1	600 (29.9)	558 (25.8)	178 (21.4)	
≥2	232 (11.6)	292 (13.5)	68 (8.2)	
CV support n(%)	1035 (51.5)	1413 (65.3)	513 (61.6)	<0.001
Adj OR (95% CI)	REF	1.80 (1.56, 2.08) p<0.001	1.51 (1.25, 1.83) p=0.016	
RRT n(%)	235 (11.7)	304 (14.0)	75 (9.0)	<0.001
Adj OR (95% CI)	REF	1.18 (0.96, 1.46) p=0.106	0.85 (0.62, 1.14) p=0.207	
Number of organs supported n(%)				<0.001
1	954 (47.5)	737 (34.0)	314 (37.7)	
2	838 (41.7)	1139 (52.6)	450 (54.0)	
3	216 (10.8)	289 (13.3)	69 (8.3)	
Duration of support MV med (1st,3rd,max quartiles)	2 (1, 3, 135)	2 (1,4,60)	2 (1, 3, 40)	<0.001
Survivors	2 (1,3,135)	2 (1,3,45)	2 (1, 3, 35)	0.012
Non Survivors	3 (2, 8,57)	3 (2,8,60)	2 (2, 4,40)	<0.001
RRT med (1st,3rd,max quartiles)	0 (0,0,58)	0 (0,0,27)	0 (0,0,12)	<0.001
Survivors	0 (0,0,48)	0 (0,0,22)	0 (0,0,11)	0.007
Non survivors	0 (0,2,58)	0 (0,1,27)	0 (0,0,12)	0.025
CV support med (1st,3rd,max quartiles)	1 (0,2,63)	1 (0,3,34)	1 (0,3,19)	<0.001
Survivors	0 (0,2,63)	1 (0, 2,24)	1 (0,2,19)	<0.001
Non survivors	2 (1,5,27)	2 (2, 5,34)	2 (1,4,13)	0.025
LOS ICU med (1st,3rd,max quartiles)	2 (1, 5, 162)	3 (1,6,89)	2 (1, 5, 44)	0.008

Survivors	2 (1,5, 162)	3 (1,6,89)	2 (1, 5, 44)	0.003
Non Survivors	3 (1, 9, 78)	2 (1,8,59)	2 (1, 5, 39)	0.055
Mortality				
ICU n(%)	255 (12.7)	472 (21.8)	211 (25.3)	<0.001
Adj OR (95% CI)	REF	2.04 (1.66, 2.52) p<0.001	3.14 (2.44, 4.05) p<0.001	
1 year n(%)	526 (26.2)	949 (43.8)	465 (55.8)	<0.001
Adj OR (95% CI)	REF	2.21 (1.90, 2.57) p<0.001	4.25 (3.50, 5.17) p<0.001	

Table 4: ICU and 1 year mortality, stratified by age and type of admission. MVDay1: Mechanically ventilated on day of admission. Elective Surgical n(%): n and % mortality for all Elective Surgical patients. REF: Reference category for Odds Ratio. Confounders: sex, socioeconomic status, presence and number of comorbidities, number of admissions in the past year, admission from non-home residence, primary diagnosis, type of admission, acute physiology score, and mechanical ventilation on day of admission.

	<65	%	65-79	%	≥80	%
ICU Mortality n (%)	3804	17.0	3470	25.0	1022	26.5
ICU mortality adjusted OR (95% CI)	REF		1.75 (1.64, 1.87)		2.33 (2.11, 2.58)	
Elective Surgical n(%)	34	1.2	95	3.2	22	3.2
Emergency Surgical n(%)	408	9.0	608	17.5	310	20.2
Non-operative n(%)	3362	22.6	2767	37.4	690	42.2
MVDay1 n(%)	3312	22.8	2847	34.2	775	37.3
1 year mortality n(%)	6166	27.6	6093	43.8	2017	52.2
ICU mortality adjusted OR (95% CI)	REF		2.15 (2.03, 2.27)		3.72 (3.42, 4.06)	
Elective Surgical n(%)	324	11.1	519	17.4	159	23.2
Emergency Surgical n(%)	878	19.4	1304	37.4	767	49.9
Non-operative n(%)	4964	33.4	4264	57.6	1091	66.6
MVDay1 n(%)	4861	33.5	4401	52.9	1275	61.4

Table 5: Discharge disposition of hospital survivors, stratified by age category. P value is Chi² test across discharge disposition of hospital survivors.

	<65	%	65-79	%	≥80	%	p value
Patients dying in hospital	4978	22.2	4951	35.1	1651	42.7	
Patients surviving to hospital discharge	17395	77.8	8953	64.4	2214	57.3	
Discharge disposition of hospital survivors							
Home	16064	92.3	8103	90.5	1818	82.1	<0.001
Institution/Hospice	150	0.9	122	1.4	86	3.9	
Rehab	814	4.7	604	6.7	265	12.0	
Other	367	2.1	124	1.4	45	2.0	