Research Article

Do Intensive Care Unit treatment modalities predict mortality in geriatric patients: An observational study from an Indian Intensive Care Unit

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Abstract

Background: Ageing being a global phenomenon, increasing number of elderly patients are admitted to Intensive Care Units (ICU). Hence, there is a need for continued research on outcomes of ICU treatment in the elderly. **Objectives:** Examine age-related difference in outcomes of geriatric ICU patients. Analyze ICU treatment modalities predicting mortality in patients >65 years of age. **Materials and Methods:** A retrospective observational study was conducted in 2317 patients admitted in a multi-specialty ICU of a tertiary care hospital over 2-year study period from January 1, 2011 to December 31, 2012. A clinical database was collected which included age, sex, specialty under which admitted, APACHE-II and SOFA scores, patient outcome, average length of ICU stay, and the treatment modalities used in ICU including mechanical ventilation, inotropes, hemodialysis, and tracheostomy. Patients were divided into two groups: <65 years (Control group) and >65 years (Geriatric age group). **Results:** The observed overall ICU mortality rate in the study population was 19.6%; no statistical difference was observed between the control and geriatric age group in overall mortality ($P > 0.05$). Mechanical ventilation ($P = 0.003$, odds ratio [OR] =0.573, 95% confidence interval [CI] =0.390–0.843) and use of inotropes ($P = 0.018$, OR = 0.661, 95% CI = 0.456–0.958) were found to be predictors of mortality in elderly population. On multivariate analysis, inotropic support was found to be an independent ICU treatment modality predicting mortality in the geriatric age group (β coefficient = 1.221, $P = 0.000$). **Conclusion:** Intensive Care Unit mortality rates increased in the geriatric population requiring mechanical ventilation and inotropes during ICU stay. Only inotropic support could be identified as independent risk factor for mortality.

Keywords: Geriatrics, hemodialysis, Intensive Care Unit outcomes, inotropes, mechanical ventilation, tracheostomy

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Introduction

Ageing of the population is a global phenomenon.[1] The fastest growing segment of population worldwide includes the aged over 65-year.[1] It is predicted that by 2050, the elderly population of the world will exceed that of the young.[2] As the population demographics are changing, there is likely to be an increase in the number of geriatric patients being admitted to Intensive Care Units (ICUs).[2] As per the literature, the elderly patients makeup between 26% and 51% of ICU admissions.[3] Committee on Manpower for Pulmonary and Critical Care Societies study showed that 56% of the ICU-days were used for patients over 65-year.[4] This emphasizes the need for continued research on outcomes of intensive care for the elderly, especially in the developing South-East Asian countries with constraints on resources allocated to health care. Several studies have postulated different predictors of mortality in geriatric ICU patients.[1-3] A vast data on the ICU outcomes of the geriatric population in the western world is available, but the data on outcomes in ICUs of developing countries

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like India is scarce. The current study was designed to examine the age-related difference in mortality in ICU patients and assess the ICU treatment modalities affecting mortality in elderly patients >65 years of age in an Indian ICU setting.

Materials and Methods

Hospital setting and study design

After approval from the hospital ethics committee, a retrospective observational study was conducted in a 350 bedded tertiary care, Joint Commission International-accredited super-specialty hospital in India. It is a 24 bedded multi-specialty adult ICU with an average of 100 admissions per month, managed by full-timer intensivists. The criterion for ICU admission is not stringent and is decided by the admitting primary physician and the intensivist, based on the clinical and physiological condition of the patient. Patients from all specialties are admitted. No patient is refused admission in to the ICU based on age. No treatment option is restricted to a specific group of patients during the ICU stay.

A clinical database of all consecutive ICU admissions was collected retrospectively from the hospital database system for a 2-year study period from January 1, 2011 to December 31, 2012. Patients who were shifted from the ICU towards and then readmitted in the ICU were excluded from the study, that is, only the first ICU admission of the patients was included. Patients with incomplete records were excluded. Data collected included age, sex, specialty under which admitted, admitting diagnosis, APACHE-II and SOFA scores at the time of ICU admission and the patient outcome. Average length of ICU stay (ALOS) was calculated from the time of admission in ICU to discharge from ICU or death. Data were also collected for treatment modalities used during the ICU stay including use of mechanical ventilation (invasive or noninvasive), inotropes, hemodialysis or slow low-efficiency dialysis and tracheostomy. For the study purpose, all patients were divided into two groups: <65 years (Control group, Group C) and >65 years (Geriatric age group, Group G).

Statistics

Data were expressed as mean ± standard deviation and percentages. Continuous variables with the normal distribution were evaluated using parametric method Student's *t*-test and categorical variables using Chi-square test. Patient characteristics and odds ratio (OR) and corresponding confidence intervals (CI) were calculated by step-wise logistic regression analysis to identify independent risk factors and control confusion effects. Only the significant variables in univariate analysis were submitted to logistic regression. All significance probabilities (*P* values) presented were of the double-tailed type and values of <0.05 were considered as statistically significant. Statistical analysis was performed using the IBM SPSS statistics version 17.0.

Results

During the study period, a total of 2364 patients were admitted in the ICU. The medical records of 47 patients were found to be incomplete, and these patients were excluded from the study. Of the 2317 patients, 1101 (48%) were in Group C, while 1216 (52%) were in Group G. The average age in Group C was 47.64 ± 12.87 years while in Group G was 73.8 ± 7.15 years. Male to female ratio in Group C was 364 (33.1%): 737 (66.9%) and in Group G was 478 (39.3%): 738 (60.7%). No statistical difference was observed in the demographic profile of two groups ($P > 0.05$) [Table 1]. The specialty wise admission of patients is as shown in Figure 1. The maximum admissions were in Neurosciences. Compared with the control group, geriatric patients were likely

Table 1: Demographic profile

	Group C	Group G	*P*
Total patients, *n* (%)	1101 (47.5)	1216 (52.5)	
Age (years±SD)	47.64±12.87	73.8±7.15	0.000
Gender, *n* (%)			
Female	364 (33.1)	478 (39.3)	0.001
Male	737 (66.9)	738 (60.7)	
APACHE-II score	15±6.32	18.17±8.5	0.036
SOFA score	6.06±2.18	8.01±1.3	0.000
ALOS (days±SD)	8.36±10.14	11.42±17.41	0.000
Mortality, *n* (%)	211 (19.2)	244 (20.1)	0.311
Sex versus mortality			
Female	69 (33)	81 (33)	0.496
Male	142 (67)	163 (67)	

ALOS: Average length of ICU stay; ICU: Intensive Care Unit; SD: Standard deviation

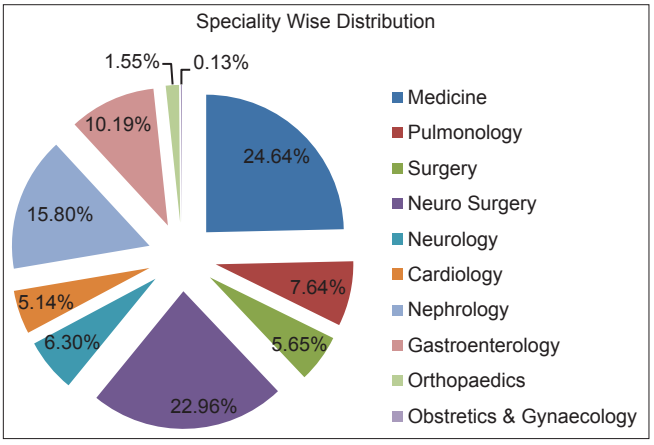

Figure 1: Specialty wise distribution of the study population

to be sicker at the time of admission as shown by significantly higher APACHE-II scores (18.17 ± 8.5 vs. 15 ± 6.32, $P < 0.05$) and SOFA scores (8.01 ± 1.3 vs. 6.06 ± 2.18, $P < 0.05$). The average duration of ICU stay in Group C was 8.36 ± 10.14 days, whereas in Group G was 11.42 ± 17.41 days. ALOS was significantly more in geriatric age group ($P < 0.05$).

The overall observed ICU mortality was 19.6%. On statistical analysis, no association was found between mortality and sex ratio preference in both the age groups ($P > 0.05$). The ICU mortality rate in Group C was 19.2% (211 deaths), while in Group G, was 20.1% (244 patients) ($P = 0.311$). There was no statistical difference in the frequency of treatment modalities used in two groups in the form of mechanical ventilation, hemodialysis, inotropes and tracheostomy ($P > 0.05$) [Table 2].

Overall 652 patients (28%) required mechanical ventilation. The mortality rate in patients requiring mechanical ventilation was 27%. 298 patients required ventilatory support in Group C (27.1%), of which 66 (22%) expired while 352 patients (29%) in Group G required ventilatory support, of which 108 (30.6%) expired. The mortality rate was significantly higher in geriatric patients requiring mechanical ventilation than the Group C patients ($P = 0.003$, OR = 0.573, 95% CI = 0.390–0.843) [Table 3].

In total, 641 patients (27.7%) required inotropic support during ICU stay. The overall mortality rate for patients on inotropes was 34%. In Group C, 298 patients (27.1%) required inotropic support, of which 89 patients (29.8%) died, while 343 patients (28%) in Group G required inotropic support, of which 128 patients died (37.3%). There was a significant difference in mortality in geriatric and control groups requiring inotropes ($P = 0.018$, OR = 0.661, 95% CI = 0.456–0.958).

In our study, 228 patients (10%) required hemodialysis treatment and the mortality rate for patients requiring hemodialysis was 31%. A total of 107 patients (9.7%) in Group C required hemodialysis out of which 33 (30.8%) expired while 111 patients (9.1%) in Group G underwent hemodialysis during their ICU stay, of which 38 died (34.2%). No significant difference in mortality was observed in Groups G and C requiring hemodialysis in ICU ($P = 0.543$, OR = 1.005, 95% CI = 0.605–1.67).

Tracheostomy was done in 109 patients (5%) during the study period. The mortality rate for tracheostomised patients was 30%. In Group C, 46 patients (4.2%) required tracheostomy of which 12 (28.6%) died while 63 patients (5%) in Group G were tracheostomised during ICU stay, of which 21 died (33%). The mortality rate did not differ significantly in Group G and C patients requiring tracheostomy ($P = 0.155$, OR = 0.649, 95% CI = 0.307–1.335).

The APACHE-II score (16.42) and SOFA score (6.87) were significantly higher in nonsurvivors in the study ($P < 0.05$) as shown in Table 4.

On univariate analysis of the ICU treatment modalities, it was observed that need for mechanical ventilation ($P = 0.003$) and inotropes ($P = 0.018$) were predictors of mortality in geriatric age group [Table 3].

On applying the regression model by means of multivariate analysis, it was observed that the inotropic support was the only variable that independently discriminated ICU mortality ($P = 0.000$) [Table 5].

Table 2: Treatment modalities

	Group C (%)	Group G (%)	P	Odds ratio	95% confidence interval	
					Lower	Upper
Mechanical ventilation	298 (27.1)	354 (29.1)	0.147	0.904	0.754	1.084
Hemodialysis	107 (9.7)	111 (9.1)	0.339	1.072	0.811	1.416
Tracheostomy	46 (4.2)	63 (5.2)	0.149	0.798	0.541	1.178
Inotropes	298 (27.1)	343 (28.2)	0.286	0.945	0.787	1.134

Table 3: Predictors of mortality in geriatric age group

	Group C (%)	Group G (%)	P	Odds ratio	95% confidence interval	
					Lower	Upper
Patients expired	211 (46.40)	244 (53.60)	0.311	0.944	0.769	1.160
Mechanical ventilation	66 (22.1)	108 (30.50)	0.003	0.573	0.390	0.843
Hemodialysis	33 (30.8)	38 (34.2)	0.543	1.005	0.605	1.670
Tracheostomy	12 (26.08)	21 (33.3)	0.155	0.640	0.307	1.335
Inotropes	89 (29.9)	128 (37.3)	0.018	0.661	0.456	0.958

Discussion

In the present study in a tertiary care Indian ICU, we had 52% patients >65 years, which is similar to the US data varying between 42% and 52%.[5] In a Lithunian ICU also, elderly patients comprised of 51% of study population.[6] This demographic transition in ICU admissions warrants more close observation of the outcomes in geriatric patients admitted to the ICUs and the treatment modalities affecting the outcome.

We found overall ICU mortality of ~ 20% in our

Table 4: APACHE-II and SOFA scores as predictors of mortality in overall study

	Survivors	Non-survivors	*P*
APACHE-II score	16.42±2.4	17.76±3.07	0.000
SOFA score	6.87±1.87	7.95±2.39	0.000

Table 5: Multivariate analysis of risk factors predictive of ICU mortality in geriatric patients

	β-coefficient	*P*
Mechanical ventilation	−0.305	0.074
Inotropes	−1.221	0.000

study subjects, with no difference between the control group and the geriatric population (P >0.05). Different studies in the literature have studied the association of age with the outcome in geriatric patients. Rosenthal *et al*. in a multihospital study of 38 ICUs found an age-related increase in mortality in 1,50,000 consecutive admissions.[7] They concluded that the adjusted odds of death increased with each 5-year age increment. Maia found 4 times increased risk of death in patients aged >75 years when compared with those between 60 and 74 years (P = 0.001).[8] Vosylius *et al*. also had a similar observation with 39% mortality in >75 years age group when compared with 18% in those <65 years (P < 0.001).[6] Stein *et al*. in a study on 199 patients concluded that age >76.9 years was an independent determinant of mortality (P < 0.001, OR = 1.08, CI 95% 1.01–1.16).[1] However, many other studies could not establish a positive relationship between age and mortality. Belayachi *et al*. in a study on elderly subjects admitted in a Moroccan ICU could not find an association of age with mortality.[2] Chelluri *et al*., in 97 ICU patients and Tang, in 365 ICU patients on mechanical ventilation concluded that age itself was not a predictor of mortality.[9,10] van den Noortgate *et al*. in their study in very elderly patients could not correlate age with greater in-hospital mortality.[11] Rockwood *et al*. in a two-center study on 1-year outcome observed that although ICU and 1-year mortality rates differed between >65 years and <65 years, but age was not a major contributor to the variance in outcome.[12] de Rooij *et al*., in a meta-analysis from 12 prospective and retrospective studies, also concluded that it is not age *per se* but factors such as severity of illness and premorbid functional status that are responsible for poor prognosis.[13] In a review by Boumendil *et al*., the authors commented that age itself explains only a small part of the increased hospital mortality, suggesting that specific information such as functional, cognitive, and nutritional status, as well as co-morbidities, should be collected to predict mortality in elderly ICU patients.[14]

Since most studies do conclude that age is not a major contributor towards mortality, so the treatment options should not vary with age. Furthermore, no specific therapy should be withheld considering increasing age as a discriminating factor. Boumendil *et al*. in his review also concluded that it is impossible to define evidence-based recommendations for ICU admission of the elderly.[14] In our study, we found no statistical difference in the treatment modalities offered to both the groups in the form of mechanical ventilation, hemodialysis, inotropic support or tracheostomy (P > 0.05) [Table 3].

We found the ICU mortality in geriatric patients to be 20.1%. Studies have reported the mortality rates in ICU patients varying from 3% to 64%, depending upon the type of subjects studied.[15] Studies with lower mortality enrolled mostly surgical and/elective patients while worse results were found with nonsurgical patients.[16-18] Our study population comprised of a mixed medical and surgical cases and the overall mortality in both the groups corresponds approximately to that expected as per the APACHE-II and SOFA scores.

We observed that mechanical ventilation and inotropes were significant treatment factors for ICU mortality in geriatric patients. However on multivariate analysis, only inotropic support was found to be independently associated with increased mortality. Mortality rate for our geriatric patients on mechanical ventilation was 44%, which is similar to the previous studies.[19-22] Overall mortality in these studies ranged between 41% and 78%.[23-27] However, one study reported 100% mortality for patients >85 years on mechanical ventilation.[23] In our study, we found that the odds of having survival in geriatric ICU patients on mechanical ventilation is 0.573 times the young patients on ventilation. Stein *et al*. in a Brazilian study in 199 elderly patients >65 years also found the need for mechanical ventilation as an independent determinant of mortality (P < 0.001, OR = 3.57, CI 95% 1.24–10.3).[1] Rellos *et al*., in oldest-old patients also observed the need for mechanical ventilation as a predictor of all-cause in-hospital mortality (P = 0.01).[28] Ip *et al*. in a study on 150 patients >70 years also found mechanical ventilation as a poor prognostic indicator (P < 0.05).[29] An association of receipt of mechanical ventilation and an increase in long-term mortality for survivors of severe sepsis has been identified in a recent study by Lemay *et al*.[30] van den Noortgate *et al*. found mechanical ventilation as a factor associated with mortality (χ^2; P = 0.00005) but on multivariate analysis, similar to our findings, they also could not attribute

mechanical ventilation as an independent predictor of mortality in very elderly patients.[11]

We also found that the odds of survival in geriatric patients requiring inotropic support is 0.661 times than in the younger population <65 years (P = 0.000, β coefficient = 1.221). Inotropic support has been associated with mortality in literature. van den Noortgate *et al*. in a study on 104 patients >85 years found inotropes as an independent risk factor in mortality (χ^2; P = 0.00001, β-coefficient = 0.9698).[11] Belayachi *et al*. in a Moroccan ICU also found shock as a significant risk factor predicting mortality in patients >65 years (OR = 11.5, CI 95% 3.7–35.7, P < 0.001).[2] Friedrich *et al*. also associated use of inotropes or vasopressors with long-term ICU mortality (OR = 7.1, 95% CI 2.6–19.3).[31]

Although various researchers have also found an association of need for hemodialysis and ICU mortality, but we could not establish a correlation between the two in our study. Mortality in patients requiring dialysis in our patients was 32.5%, and there was no difference in the two age groups (P = 0.543). Though raised blood urea and creatinine levels have been proposed as factors affecting mortality in geriatric patients by van den Noortgate *et al*., Vigder *et al*. and Belayachi *et al*., but on multivariate analysis, they could not be proposed as independent predictors for mortality.[2,11,32] The Dialysis Outcomes and Practice Patterns Study (DOPPS) study to assess hemodialysis practices and outcomes among elderly versus young patients on chronic hemodialysis reports 3–6 fold higher mortality risk in the elderly population.[33] However, DOPPS study includes patients on chronic hemodialysis and hence the results cannot be extrapolated for the ICU population as such. Romao Junior in a series of 361 patients with acute renal failure (ARF) identified the need for dialysis as a poor prognostic factor in elderly patients with ARF.[34]

We found no difference in outcomes of tracheostomised patients in two age groups in our study (P = 0.155). Numerous studies in the literature support our findings. Engorgen, in a study on 228 patients over 65-year, did not observe any difference in hospital and hospice mortality in younger elderly (65–74 years) and older elderly (>75 years) patients receiving tracheostomy for respiratory failure (P > 0.05).[35] Ho *et al*., in an audit of characteristics and outcomes in 168 adult ICU patients with tracheostomies concluded that tracheostomy appears to be a relatively safe technique in the ICU population and is not associated with adverse outcomes.[36] Frutos-Vivar *et al*. in a vast study in 361 ICUs across 12 countries observed that adjusting by other variables, tracheostomy was independently related with survival in the ICU (OR = 2.22; 95% CI, 1.72–2.86) but in-hospital mortality was similar with or without tracheostomy (39% vs. 40%, P =0.65).[37] In a retrospective study by Baskin *et al*., of 78 elderly patients who received tracheotomies for respiratory failure demonstrated that a large proportion of elderly, severely ill patients with respiratory failure suffer poor outcomes after tracheotomy with a death rate up to 56%.[38] Hence, they concluded that more stringent criteria are necessary for performing the tracheotomy in this patient population.

Thus, in our study the ICU mortality rates were similar regardless of the age. However, mortality rates increased in the geriatric population requiring mechanical ventilation and inotropes during ICU stay. However, only inotropic support could be proposed as an independent risk factor for mortality in the geriatric population. Thus, the geriatric patients requiring mechanical ventilation and inotropic support in ICU should be prognosticated accordingly.

Limitations

A few limitations of our study need to be acknowledged. First, this is a retrospective, observational study, so both internal and external validity is relative and uncertain. Our analysis focused only on ICU mortality, and we did not examine postdischarge mortality or long-term prognosis. Although we included all consecutive ICU admissions in our study population, we do not have any record of the potential differences in requests for withdrawal of treatment by age. But as shown in previous studies, treatment limitations are likely to differ according to age.[39-41] It is possible that variations in mortality may be due to prognostic factors, baseline functional status and other physiological parameters, which have been found to be independent predictors of mortality and more prevalent in older patients.[2,3,13] We did not include this information in our study as we wanted to specifically study the impact of ICU treatment modalities on geriatric mortality. Also, we did not assess the long-term mortality which could have modified our results. Finally, our study was limited to a single tertiary care center. Regardless, this may limit the generalization of our findings to other geographic regions and other hospital settings.

Conclusions

The findings of the current study provide important descriptive information about the risk factors for mortality in geriatric patients requiring ICU care. Our

findings suggest that need for mechanical ventilation and inotropic support were the ICU treatment modalities associated with higher death rates in geriatric patients. The need for inotropic support during ICU stay was an independent predictor of mortality in geriatric patients. Also, we conclude that hemodialysis and tracheostomy were not associated with increased mortality. One potential use of our results would be to incorporate the risk estimates of death into a real-time prognostic model to be used in the ICU when making care decisions or when conveying prognoses to patients and families. We do not believe that these methods alone should substitute for clinical judgment or should be used alone to determine the specific treatments for individual patients. Further studies of the applicability of mortality estimates in geriatric patients in ICU care are clearly warranted.

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