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Original article

Intensive Care Morbidity and Mortality and Their Associated Factors: A National Study in Egypt

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Abstract:

Background: The patterns of comorbidity upon intensive care unit (ICU) admission and mortality upon discharge are not well-studied in Egypt. **Aim:** Therefore, this descriptive cross-sectional study aims to describe these patterns and to highlight their associated factors at the national level. **Methods:** The study enrolled 1132 ICU patients representing the seven Egyptian regions. Comorbidities were assessed by calculating Charlson comorbidity index (CCI) which was classified into low (≤6) and high (>6) CCI based on median value. Discharge data including condition at discharge were reported. **Results:** Results revealed male to female percentage of 58.4% and 41.6%, median age of 58 years, rural to urban percentage of 60.3% and 39.7%. Overall mortality was 24% at discharge. The median ICU stay was two days ranging from 0 to 27 days. The most frequent diagnosis was acute myocardial infarction (28.8%). High CCI was 34.9%. Older patients (≥60 years), female patients, and patients with long ICU stay had 7.40-, 1.34-, and 1.91-times higher odds to have high CCI; respectively. Also, older patients (≥60 years), patients from urban areas, patients with short ICU stay, and patients with high CCI had 1.54-, 1.71-, 1.52- and 1.53-times higher odds to die in ICU; respectively. **Conclusion:** In conclusion, this study revealed a 24% ICU mortality which is related to old age, urban residency, short ICU stay, and high CCI.

Key words: Intensive Care Unit (ICU), Charlson Comorbidity Index (CCI), Morbidity, Mortality.

List of Abbreviations: ICU = Intensive Care Unit, CCI = Charlson Comorbidity Index.

Introduction

Intensive care medicine has grown significantly over decades and now consumes a considerable part of the income of many countries worldwide (1). Also, critically ill patients are a highly heterogenous population who tend to have many comorbidities. The overall ICU mortality rates vary from 11.9% (Oceania) to 39.5% (Africa) (2). However, the ICU mortality rate varies with patients' demographics, region, and morbidity type. The concurrent comorbidities including metabolic, cardiac, renal hematologic and hepatic comorbidities before admission should be considered. These can be assessed using Charlson's weighted index of comorbidities (CCI) that has been shown to predict hospital mortality in critically ill patients (3). To the best of authors' knowledge, the pattern of comorbidity on admission to ICU and the pattern of mortality on discharge from ICU are not well-studied in Egypt. Therefore, this study aims to describe the pattern of morbidities and mortality and their associated factors at the national level.

Patients and methods:

Study locality and duration: This study was conducted in the seven Egyptian regions declared by General Organization for Physical Planning (GOPP), during a calendar year (2017).

Study Design: A descriptive cross-sectional study.

Target population: All adult patients admitted to the participating Egyptian governmental ICUs.

Sample size:

Sample size was calculated using MedCalc Statistical Program (https://www.medcalc.org). Annual statistical report of MOHP revealed that the mortality among ICU admission was 11.7% during the year 2016 (Therapeutic Medicine Information Center). With α-error of 5%, study power of 80% and effect size of 3%, a minimum total sample of 753 patients is required. In this study, the authors were able to enroll a larger total number of patients (N=1132).

Sampling method:

A sample of ICUs selected from all over Egypt using the multi-stage stratified sampling method with proportionate allocation. By proportionate stratification, the sample size of each stratum was proportionate to the total ICU admissions in the year 2016.

Methodology:

Questionnaire was developed to collect the following data:

1. Hospital data e.g., hospital name, location, and number of ICU beds.

2. Patients' data e.g., age, sex, and residency.

3. Admission data including the date & time of admission, and admission diagnosis.

4. Charlson's comorbidity index (CCI) was calculated by summing up the assigned weight for underlying disorder; '1' for myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disease, ulcer disease, mild liver disease, and diabetes; '2' for hemiplegia, moderate/severe renal disease, diabetes with end-organ damage, localized solid tumor, leukemia and lymphoma; '3' for moderate/severe liver disease; and '6' for metastatic solid tumor. In this study, CCI was classified into low (≤ 6) and high (>6) CCI based on median value.

5. Discharge data including the date of discharge and condition at discharge, final diagnosis, and mortality. Age was classified into elderly (≥ 60 years) vs adults (18-<60 years), ICU stay was classified into short stay (≤ 2 days) and long stay (> 2 days) based on median value.

6. Data collection approach: the above-mentioned data were collected from patients' files after their discharge.

Ethical consideration:

- Official approval of the participating ICUs.
- Approval of IRB of Mansoura Faculty of Medicine (code: MD/17.11.01).

Statistical analysis:

Data were entered and analyzed using IBM-SPSS software (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Categorical data were expressed as count and percent. Quantitative data were initially tested for normality using Kolmogorov-Smirnov test. Data were found to be non-parametric in distribution and expressed as median (25^{th} and 75^{th} percentiles). Qualitative data were compared by chi-square test (or Fisher's exact test). Crude odds ratios and its 95% CI were calculated. Significant factors in bivariate analysis were entered into binary logistic regression analysis using forward Wald method to find out the independent predictors of the dichotomous outcome with calculation of adjusted odds ratios and their 95% CI. P values ≤ 0.05 will be considered statistically significant.

Results:

Table (1): Sociodemographic characteristics of study participants (n=1132):

Characteristic	N (%)
Age (years):	
18-	82 (7.2%)
30-	69 (6.1%)
40-	150 (13.3%)
50-	282 (24.9%)
60-	313 (27.7%)
70-	170 (15%)
80+	66 (5.8%)
Median (Q1-Q3) [Minimum-Maximum]	58 (48 - 66) [18 - 110]
Sex:	
Male	661 (58.4%)
Female	471 (41.6%)
ICU stay (days):	
Median (Q1-Q3) [Minimum-Maximum]	2 (1 - 4) [0 - 27]
Region:	
Greater Cairo Region	129 (11.4%)
Alexandria Region	134 (11.8%)
Delta Region	443 (39.1%)
Suez Canal Region	59 (5.2%)
North Upper Egypt Region	117 (10.3%)
Asyut Region	104 (9.2%)
South Upper Egypt Region	146 (12.9%)
Residence:	
Rural	683 (60.3%)
Urban	449 (39.7%)
Condition upon discharge:	
Death	272 (24%)
Improvement	756 (66.8%)
Transfer to another facility	104 (9.2%)

Data expression: Frequency (Percentage) unless otherwise stated.

Table 1 shows that male to female percentage of 58.4% to 41.6%, median age of 58 years, rural to urban percentage of 60.3% to 39.7%, a quarter of patients were non-survivors [excluding the 104 transferred cases, 272 (26.5%) dead, median ICU stay of two days ranging from 0 to 27 days.

Table 2: Morbidity pattern of studied patients (ICD-10 classification)

Category (code)	Diagnosis (code)	N (%)
Acute myocardial infarction (121)	Acute transmural myocardial infarction of unspecified site (121.3)	326 (28.8%)
Heart failure (150)	Congestive heart failure (150.0)	135 (11.9%)
Unspecified diabetes mellitus (E14)	Diabetes NOS Unspecified diabetes mellitus with renal complications (E14.2)* Unspecified diabetes mellitus with neurological complications (E14.4)** Unspecified diabetes mellitus with other specified complications (E14.6)***	154 (13.6%) 41 (3.6%) 71 (6.3%) 192 (17%)
Unspecified liver disease (K76.9)	Chronic (organic) liver disease (K76.9)	94 (8.3%)
Malignant neoplasms ((C00-C97)	Malignant neoplasm, primary site unspecified (C80.9)	16 (1.4%)
Unspecified HIV disease (B24)	Acquired immunodeficiency syndrome [AIDS] NOS	1 (0.088)
Chronic kidney disease (N18)	Chronic kidney disease stages 3-5 (N18.3-N18.5)	78 (6.9%)
Other chronic obstructive pulmonary disease (J44)	Unspecified chronic obstructive pulmonary disease (J44.9)	29 (2.6%)
Other peripheral vascular diseases (I73)	Unspecified peripheral vascular diseases (I73.9)	29 (2.6%)
Unspecified dementia (F03)	Unspecified dementia (F03)	58 (5.1%
Stroke, not specified as hemorrhage or infarction (I64)	Cerebrovascular accident NOS	141 (12.5%)
Hemiplegia (G81)	Hemiplegia, unspecified (G81.9)	127 (11.2%)
Systemic connective tissue disorders (M30-M36)	Systemic involvement of connective tissue, unspecified (M35.9)	10 (0.9%)
Leukemia of unspecified cell type (C95)	Leukemia of unspecified cell type (C95)	0 (0%)
Non-Hodgkin lymphoma, unspecified (C85.9) **Hodgkin lymphoma, unspecified (C81.9)**	Malignant lymphoma NOS Malignant lymphoma, Hodgkin	0 (0%)
Peptic ulcer, site unspecified (K27)	Gastroduodenal ulcer NOS, peptic ulcer NOS	15 (1.3%)
Acute ischemic heart disease, unspecified (124.9)	Acute coronary syndrome (NEC 124.9)	230 (20.3%)

Table (3): Factors associated with high CCI

Factor	Total N (%)	High CCI N (%)	P value	COR (95% CI)	AOR (95% CI)
Overall	1132	395 (34.9%)	-	-	-
Age:			**<0.001**		
< 60	583 (51.5%)	86 (14.8%)		r(1)	r(1)
≥ 60	549 (48.5%)	309 (56.3%)		7.44 (5.60-9.89)	7.40 (5.54-9.86)
Sex:			**0.002**		
Male	661 (58.4%)	206 (31.2%)		r(1)	r(1)
Female	471 (41.6%)	189 (40.1%)		1.48 (1.16-1.90)	1.34 (1.01-1.76)
Residence:			0.235		-
Rural	683 (60.3%)	229 (33.5%)		r(1)	
Urban	449 (39.7%)	166 (37%)		1.16 (0.91-1.49)	
ICU stay:			**<0.001**		
Short (≤ 2 days)	622 (54.9%)	176 (28.3%)		r(1)	r(1)
Long (> 2 days)	510 (45.1%)	219 (42.9%)		1.91 (1.49-2.44)	1.91 (1.45-2.52)

COR=Crude Odds ratio, AOR=Adjusted Odds ratio, R=Reference category, CI=Confidence interval. Nagelkerke R^2 =27.4

Table 3 reveals that logistic regression model was statistically significant, χ^2 (3) = 250.851, p ≤**0.001**. The model explained 27.4% (Nagelkerke R^2) of the variance in high CCI and correctly classified 73.1% of cases. All three predictor variables, older age, female sex, and long ICU stay were statistically significant independent predictors of high CCI. Older patients (≥ 60), female patients, and patients with long ICU stay had 7.40-, 1.34-, and 1.91-times higher odds to have high CCI; respectively.

Table (4): Overall mortality and its associated factors

Factor	Total N (%)	Mortality N (%)	P value	COR (95% CI)	AOR (95% CI)
Overall	1132	272 (24%)	-	-	-
Age:			**≤0.001**		
< 60	583 (51.5%)	111 (19.0%)		r(1)	r(1)
≥ 60	549 (48.5%)	161 (29.3%)		1.76 (1.34-1.33)	1.54 (1.13-2.10)
Sex:			0.907		-
Male	661 (58.4%)	158 (23.9%)		r(1)	
Female	471 (41.6%)	114 (24.2)		1.02 (0.77-1.34)	
Residence:			**≤0.001**		
Rural	683 (60.3%)	136 (19.9%)		r(1)	r(1)
Urban	449 (39.7%)	136 (30.3%)		1.75 (1.33-2.30)	1.71 (1.29-2.26)
ICU stay:			**0.014**		
Long (> 2 days)	510 (45.1%)	105 (38.6%)		r(1)	r(1)
Short (≤ 2 days)	622 (54.9%)	167 (61.4%)		1.42 (1.07-1.87)	1.52 (1.14-2.03)
CCI:			**≤0.001**		
Low (≤ 6)	737 (65.1%)	150 (20.4%)		r(1)	r(1)
High (> 6)	395 (34.9%)	122 (30.9%)		1.75 (1.32-2.31)	1.53 (1.11-2.10)

COR=Crude Odds ratio, AOR=Adjusted Odds ratio, R=Reference category, CI=Confidence interval. Nagelkerke R^2 =5.9

Table 4 shows that logistic regression model was statistically significant, χ^2 (4) = 45.775, p **≤0.001**. The model explained 5.9% (Nagelkerke R^2) of the variance in ICU mortality and correctly classified 76% of cases. All 4 predictor variables, older age, urban residency, short ICU stay and high CCI were statistically significant independent predictors of ICU mortality. Older patients (≥ 60), patients from urban areas, patients with short ICU stay, and patients with high CCI had 1.54-, 1.71-, 1.52- and 1.53-times higher odds to die in ICU, respectively.

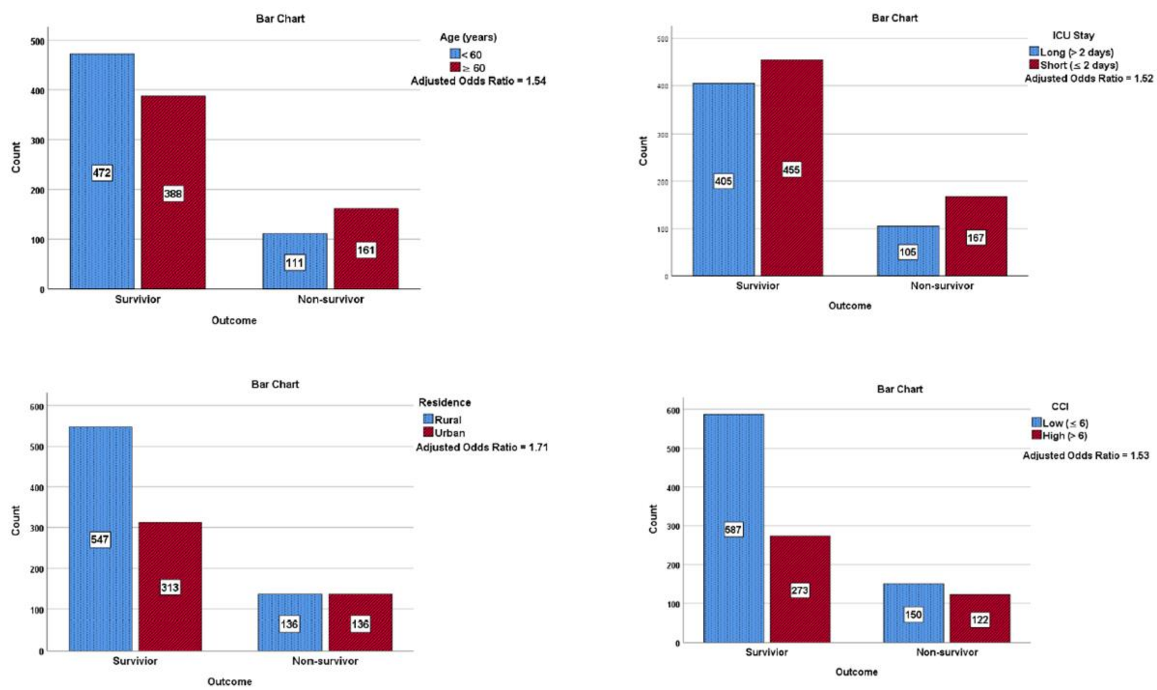

Figure (1): Predictors of ICU mortality

Discussion:

Need for ICU admission for a critically ill patient is growing all over the world (Packham and Hampshire, 2015). However, the reasons for admission might differ between different ICUs. In this study, acute myocardial infarction, congestive cardiac failure, complicated diabetes (particularly diabetic ketoacidosis) and stroke were the most frequently encountered diagnoses on admission to ICU. These results are contradictory to the findings in a study from Assiut by Mohamed et al. in 2018 (4). In their study, cardiovascular cause for ICU admission represented only 11.3%; a figure that is too low as compared to our and other published data. This may be, at least partly, due to the low mean age in their cohort (37.8 years). An explanation of the high percentage of cardiovascular reasons for ICU admissions might come from Egypt STEPS survey 2017 (5) that reported a high percentage of population aged 18 to 69 years with three or more cardiovascular risk factors (42.5%).

However, in a previous study in UK by Simpson et al. (6), cardiac causes including ischemic heart disease, circulatory collapse and shock were among the most common reasons for ICU admissions. In another study comparing ICU admissions in USA and UK (7), cardiac reasons for ICU admissions predominate in USA vs. UK admissions (44.6% vs. 27.1%). In our study, cardiac reasons constitute 40.7% OF admissions; a figure that is near to that in USA admissions. This result shades the light on the importance of preparing our ICUs to be able to receive the dominating cardiac patients. In a preliminary report from Ethiopia (8), cardiovascular disease was the commonest admission diagnosis (36.1%); a figure which is midway between USA and UK figures and lower than the frequency reported in the current study. Another study from Saudi Arabia (9) conducted during Hajj period involving multinational population with Egyptians representing 15.7% of the admitted cases. The study reported the highest frequency of cardiovascular reasons for ICU admission (63.6%). One plausible explanation for this relatively high figure is that more than one half of patients (54%) aged 60 years or more.

At the time of admission to ICU, the presence of comorbid conditions is very common affecting seriously the outcome in this critically ill population (10). In clinical practice, Charlson comorbidity index (CCI) was developed to convert the associated comorbidities into a single numeric score (11). This way of presenting comorbidities helps health professionals to stratify their critically ill patients in such a way that might assist them in creating targeted models of care thereby, improving resource allocation (12).

In this study, comorbid conditions were common, with CCI scores ranging from 1 to 18 and a median score of 6. High CCI score (>6) was observed in more than one-third of cases (34.9%).

Independent predictors of this high CCI were older age (≥ 60 years), female sex, and long ICU stay (> 2 days).

This is like that reported in 2016 (13) that an association between high CCI and increased length of hospital stay was proved (13).

The finding of high CCI among females reflects the percentage of population aged 40-69 years with a 10-year CVD risk ≥ 30%, or with existing CVD as reported by Egypt STEPS survey 2017 (5) that was higher among female than male (8.32% vs. 7.3%).

In the current study, the overall mortality at discharge was 24%. This figure is different from that reported in another Egyptian study from Assiut (4) who reported very high mortality rate of 52.3% with more than half of them aged more than 50 years. This might be due to different causes of admission which include trauma and respiratory disease as the two main reasons for admission as well as the main causes of death. These figures are higher than that reported in the United States of America with a reported ICU mortality rate that ranges from 8 to 19% (14). In another study (15), ICU mortality rate in Singapore was even lower with a reported Medical and Cardiac ICU mortality rates of 7% and 8.2%; respectively.

In current study, independent predictors of ICU mortality were older age (≥ 60-years), urban residency, short ICU stay and high CCI. Like these findings, it was reported in 2018 (4) that mortality was more among older patients, and in those who stayed less than 5 days (59.5%). In another study (16), urban slum dwellers have an increased vulnerability to cardiovascular diseases compared with the Egyptian population. The high CCI score was an independent predictor of ICU mortality supporting its use as a validated method of accounting for patients' comorbidities in ICU studies.

Conclusion and recommendations

In conclusion, ICU patients in Egypt have multiple comorbidities and high mortality. There is a need to continuous monitoring of the morbidity and mortality trends in ICU patients. There is a need to develop a national guideline for management of these high-risk groups of patients.

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