Journal of Critical Care 43 (2018) 281–287

Contents lists available at ScienceDirect

Journal of Critical Care

journal homepage: www.jccjournal.org

Characteristics and outcomes of critically-ill medical patients admitted to a tertiary medical center with restricted ICU bed capacity

Iftach Sagy [a,d,*], Lior Fuchs [a,b,d], Yuval Mizrakli [a,d], Shlomi Codish [a,d], Liran Politi [c], Lior Fink [c], Victor Novack [a,d]

[a] Clinical Research Center, Soroka University Medical Center, Israel
[b] Medical Intensive Care Unit, Soroka University Medical Center, Israel
[c] Department of Industrial Engineering & Management, Ben-Gurion University of the Negev, Israel
[d] Faculty of Health Sciences, Ben-Gurion University of the Negev, Israel

ARTICLE INFO

Keywords:
Resuscitation room
Intensive care unit
Decision making
Outcomes

ABSTRACT

Background: In the emergency department (ED) critically-ill medical patients are treated in the resuscitation room (RR). No studies described the outcomes of critically-ill RR patients admitted to a hospital with low capacity of intensive care unit (ICU) beds.
Methods: We included all medical patients above 18 who were admitted to a RR of a tertiary hospital during 2011–2012. We conducted multivariate logistic and Cox regressions and propensity score (PS) matched analysis to analyze parameters associated with the study outcomes.
Results: In-hospital mortality rate was 32.4% in ICU admitted patients compared to 52.0% of the non-ICU critically-ill patients ($p<0.001$). Age above 80, female and recent ED encounters were associated with non-ICU admissions ($p<0.05$ for all). ICU admission had a statistically significant effect on in-hospital mortality in PS matched analysis (OR 0.36, 95% CI 0.21–0.61). A marginal effect was evident in one-year survival in PS matched landmark analysis (HR 0.50 95% CI 0.23–1.06).
Conclusion: ED critically-ill medical patients who were treated in the RR had high mortality rates in an institute with restricted ICU beds availability. However, those who were admitted to an ICU showed prolonged short and perhaps long term survival compared to those who were not.

1. Background

Over the past several decades, population aging and the increase in the morbidity burden, together with an accelerated adoption of new technologies, are reflected in a growing utilization of expensive medical resources [1]. An increase in emergency department (ED) visits and admissions to intensive care units (ICUs) are well-documented examples [2,3]: from 2001 to 2009 the annual ED visits of patients older than 65 increased by almost a quarter and the ICU admissions more than doubled in the United States (US) [4].

Triage decisions in the ED impact the outcomes of critically-ill patients, as those admitted to an ICU showed higher in-hospital survival rate [5,6]. Parameters that were reported to influence ICU admission decision were the patient's age, diagnosis, functional status, illness severity index and the need of vassopressors [6-9].

Due to the high cost of ICU beds, the growing demand frequently surpasses the supply [10]. This discrepancy is region- and country-specific: the number of available ICU beds in the US and Europe is highly variable, from 25 beds per 100,000 people in the US, to 5 beds per 100,000 in the UK and 4.6 beds per 100,000 in Israel [11,12]. In low ICU resource environments, a so-called “closed door policy” for ICU admissions is frequently used, in which the ICU admission is conditional on the intensive care physician's decision. Previous studies examined the association between ED treatments of critical patients, intensive care admissions, and mortality in health systems with relatively high ICU beds availability [13-15].

Among ED patients, the most critical ones (“sickest of the sick”) are often treated in the resuscitation room (RR) [16,17]. The aim of the present study is to analyze the characteristics of medical patients who are treated in the RR in a low ICU beds availability environment and to investigate which parameters are associated with ICU admissions and with short and long term survival.

2. Methods

2.1. Study population

We obtained health data of all patients admitted to the Soroka University Medical Center (SUMC) ED and treated in the medical RR during the years 2011–2012. SUMC is an 1100-bed tertiary medical center in

* Corresponding author at: Clinical Research Center, POB 151, Beer-Sheva 84101, Israel.
E-mail address: iftachsagy@gmail.com (I. Sagy).

https://doi.org/10.1016/j.jcrc.2017.09.177
0883-9441/

Southern Israel (950 non-pediatric acute beds), serving a population of approximately 700,000 as the only hospital, and nearly 1.2 million as a tertiary hospital. SUMC has two general ICUs with 20 beds and an intensive cardiac care unit (ICCU) with 8 beds.

SUMC internal ED has over 150,000 annual visits. Approximately 500 critically-ill patients are treated in 6 beds RR annually [18]. Patients may either enter the RR directly when arriving to the ED after a quick triage or be transferred from the ED due to a deterioration in their medical condition. The treatment in the RR may include diagnostic and therapeutic measures, such as definitive airway, defibrillation, various medications, vasopressors, blood products, central lines, x-rays, point of care ultrasound, and additional imaging studies. Patients are then presented to the ICU physician and if not admitted to ICU can be mechanically ventilated and receive vasopressor therapy in an internal medicine ward. The decision of ICU admission is based solely on the intensivist opinion.

2.2. Data extraction

The study was approved by SUMC's Ethics Committee. We excluded patients whose age was below 18, who were dead upon arrival, and who were remained anonymous during their RR stay. We extracted demographic, medical history, laboratory, and clinical data from the computerized outpatient-inpatient database. We used Initial vital signs and laboratory tests that were recorded upon RR arrival. Therapeutic data, i.e., medications and medical procedures that were conducted, were extracted from the RR records.

Characteristics of the treating physician were extracted using the unique electronic login of each physician in the hospital electronic record during the medical engagement. Each physician name was cross matched with the Israeli ministry of health database to receive the type of residency, years of seniority, and gender.

Patients were identified by the national ID number which was encoded prior to the data analysis. The primary outcome of our analysis was ICU admission following RR treatment, and the secondary outcomes were in-hospital and one-year mortality.

2.3. Statistical analysis

Data are expressed as mean ± standard deviation (SD), median ± interquartile range (IQR), or number and percentage. We compared patient characteristics between ICU vs. ward admissions using *t*-test, chi-square and non-parametric tests. We considered "ICU" as either general ICU or Intensive Cardiac Care Unit (ICCU) admissions. To estimate the association of the patients and physician characteristics with ICU admissions, we conducted a forward stepwise conditional logistic regression of the dependent variable. Each set of covariates (demographic, medical history, laboratory, etc.) was entered as separate block to the model. The final model was selected based on model goodness of fit using the c-statistic and plausible clinical explanation. We used the same method to analyze covariates that were associated with in-hospital mortality. We computed a propensity score for the ICU admission. Mortality models were built in the population of ICU admitted and not admitted patients matched in a 1:1 ratio on propensity score (caliper 0.001, greedy matching) adjusted for age, gender, Charlson's comorbidity index (CCI) intubation and vasopressors use in RR. Since the availability of ICU beds is an important factor to determine patient placement, we also computed a variable of vacant ICU beds (presented in quartiles of available ICU beds during patients stay in RR), which was tested with ICU admission and in-hospital mortality. In addition, we conducted subgroup analysis (stratified by age, gender, CCI, albumin diabetes, and primary diagnosis) to analyze in-hospital mortality among ICU vs. non-ICU admissions within these subgroups. For landmark analysis of one-year mortality, we used Cox regression and matched in a 1:1 ratio propensity score (caliper 0.001, greedy matching) for ICU admission, using the same variables from the short term matching. The model was conducted in a forward stepwise conditional method [19]. Data analysis was performed using SPSS version 24.0.

3. Results

3.1. Patients characteristics

A total of 1064 medical treatments in the RR during the study period (2011 − 2012) were examined. After excluding patients who were

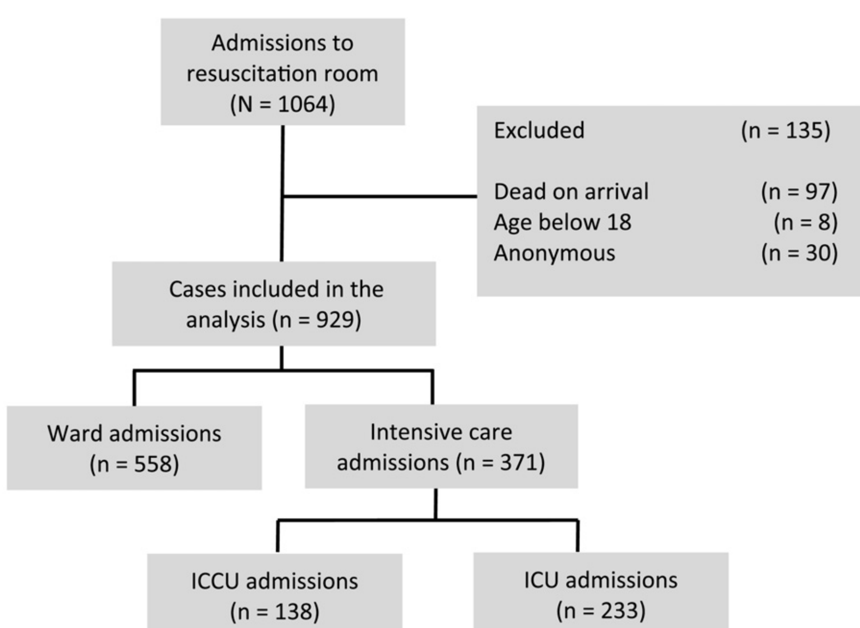

Fig. 1. Flow charts of patients who were admitted to the resuscitation room in the medical emergency department during the years 2011–2012. Abbreviations: ICU – Intensive Care Unit, ICCU – Intensive Cardiac Care Unit.

Table 1
Socio-demographic, medical, and laboratory characteristics of the study sample.

Group	Admission to ICU $n = 371$	Admission to ward $n = 558$	P value
Age (mean ± S.D)	61.5 ± 17.3	71.7 ± 17.1	<**0.001**
Age group (n,%)			<**0.001**
≤ 60	141 (40.6%)	103 (19.1%)	
60–80	169 (48.7%)	231 (42.9%)	
≥ 80	37 (10.7%)	204 (37.9%)	
Female gender (n,%)	113 (32.6%)	262 (48.7%)	<**0.001**
Jewish ethnicity (n,%)	259 (78.7%)	426 (86.4%)	**0.004**
Socio-economic decile (median, IQ range)	5 (4,5)	5 (4,5)	0.555
Distance from hospital (km) (median, IQ range)	5 (2,32)	5 (2,32)	0.669
CCI (median, IQ range)	6 (3,8)	6 (4,8)	<**0.001**
Chronic ischemic heart disease (n,%)	58 (15.7%)	55 (9.9%)	**0.009**
Congestive heart failure (n,%)	52 (14.1%)	39 (7%)	<**0.001**
Cerebral-vascular disease (n,%)	41 (11.1%)	91 (16.4%)	**0.023**
Dementia (n,%)	2 (0.5%)	35 (6.3%)	<**0.001**
Chronic pulmonary conditions (n,%)	39 (10.5%)	53 (9.6%)	0.628
Diabetes mellitus (n,%)	115 (31.1%)	138 (24.9%)	**0.039**
Malignancy (n,%)	5 (1.4%)	24 (4.3%)	**0.011**
Obesity (n,%)	49 (13.2%)	27 (4.9%)	<**0.001**
Smoking (n,%)	66 (17.8%)	36 (6.5%)	<**0.001**
Primary diagnosis in the ED (n,%)			<**0.001**
Sudden cardiac death	86 (23.2%)	96 (17.6%)	
Acute myocardial infarction	41 (11.1%)	19 (3.5%)	
Other cardiological condition	58 (15.6%)	41 (7.5%)	
Sepsis	45 (12.1%)	149 (27.2%)	
Respiratory condition	61 (16.4%)	128 (23.4%)	
Acute stroke	24 (6.5%)	61 (11.2%)	
Other	56 (15.1%)	53 (9.7%)	
Admission during night/weekend shift (n,%)	280 (75.5%)	388 (69.5%)	**0.049**
Admitted directly to RR (n,%)	91 (27.8)	135 (27.6)	0.937
Time from ED admission to RR (min) (mean ± S.D)	6 (1,51)	5 (1,33.5)	0.214
Total time spent in RR (min) (mean ± S.D)	80 (50,120)	75 (45.5117)	0.473
Previous ED visit within 1 week (n,%)	11 (3.0%)	38 (6.8%)	**0.011**
Previous ED visit within 1 month (n,%)	64 (17.3%)	158 (28.3%)	<**0.001**
Treating physician type of expertise (n,%)			**0.028**
Emergency medicine	84 (29.1%)	173 (39.5%)	
Non emergency medicine	103 (35.6%)	125 (28.5%)	
Resident (others)	102 (35.3%)	140 (32.0%)	
Years since graduation of treating physician	5 (4,13)	8 (4,14)	0.052
Treatment in RR			
Definitive airway (n,%)	245 (93.5%)	288 (83.5%)	<**0.001**
Defibrillation (n,%)	26 (7.0%)	17 (3.0%)	**0.005**
Vasopressors (n,%)	79 (21.3%)	62 (11.1%)	**0.018**
Antibiotics (n,%)	82 (22.1%)	138 (24.7%)	**0.042**
Laboratory on admission			
Hemoglobin (gr/dL) (mean ± S.D)	13.1 ± 2.5	12.1 ± 2.4	<**0.001**
White blood cells (10^9 cells/L) (mean ± S.D)	15.5 ± 6.5	14.2 ± 7.3	**0.008**
Platelets (10^9 cells/L) (mean ± S.D)	264.7 ± 0	274.2 ± 0	0.245
Creatinine (mg/dL) (mean ± S.D)	1.3 ± 1.4	1.2 ± 1.2	0.336
Albumin (mg/dL) (mean ± S.D)	3.5 ± 0.7	3.2 ± 0.7	<**0.001**
pH(mean ± S.D)	7.2 ± 0.2	7.3 ± 0.1	<**0.001**
CO_2 (mEq/L) (mean ± S.D)	52.5 ± 25.4	50.7 ± 22.4	0.317
HCO_3 (mEq/L) (mean ± S.D)	20.4 ± 6.3	22.1 ± 7	**0.001**

CCI - Charlson's comorbidity index, ED – Emergency department, RR – Resuscitation room, IQ – interquartile range, SD – standard deviation.
Bold indicate Significance level < .05.

younger than 18, dead on arrival, and those with missing identification details, there were 929 admissions included in the final analysis (Fig. 1).

Table 1 presents the baseline characteristics of patients according to the destination unit after RR treatment. Patients who were transferred to an ICU were younger, predominately male, smoking, and obese with higher rates of cardiac conditions (chronic ischemic heart disease and congestive heart failure), but had lower CCI. Patients who had significantly lower ICU admission rates had a medical history of dementia and malignancy ($p < 0.001$ and $p = 0.01$, respectively). Patients with primary diagnosis of cardiac conditions (268 patients with acute myocardial infarction, arrhythmias, heart failure, and cardiogenic shock) were more likely to be admitted to an ICCU than patients with other conditions who were admitted to ICU. Therapeutic strategies utilized at the RR, such as definitive airway, cardiac defibrillation, and vasopressor use were more common in the ICU admitted patients ($p < 0.001$, $p = 0.005$, and $p = 0.018$, respectively).

We tested the association between the number of vacant ICU beds (in quartiles) vs. ICU admissions, in-hospital mortality, and patient's length of hospitalization (Table 2). We found that higher number of vacant ICU beds were associated with neither ICU admission rate nor short term mortality ($p = 0.10$, $p = 0.52$, and $p = 0.16$, respectively).

Among the factors that were independently associated with ICU admission (Table 3) were younger age (OR 0.09, 95% CI 0.04–0.21 for advanced age), male gender (OR 0.45, 95% CI 0.0.25–0.80 for females), primary diagnosis of cardiac condition (OR 5.08, 95% CI 2.74–9.41) and ED visits during night or weekend shifts (OR 0.49, 95% CI 0.27–0.89 for morning shifts). An ED visit in the previous month was associated with decreased chance to be admitted to an ICU (OR 0.44, 95% CI 0.22–0.89). The model's c-statistic was 0.75.

3.2. Mortality analysis

Crude short and long term mortality rates were lower among ICU admitted patients as shown in Table 4. The in-hospital mortality rate was 32.4% in ICU admitted patients compared to 52.0% of the non-ICU critically-ill patients ($p < 0.001$). The survival of ICU and non-ICU admitted patients during the index hospitalization are also presented in Fig. 2 ($p < 0.001$).

Factors that were associated with in-hospital mortality are presented in Table 5. In a propensity score matched (1:1) analysis, ICU admission was associated with lower in-hospital mortality (OR 0.36, 95% CI 0.21–0.61, model c statistic was 0.74). Landmark propensity score matched (1:1) analysis for one-year survival is presented in Table 6 and Fig. 3A and B. ICU admission was associated with improved survival among patients who were treated in the RR and survived the index hospitalization in univariate survival analysis (HR 0.66, 95% CI 0.44–0.98; see ($p < 0.001$ and $p = 0.03$ in Fig. 3A and B respectively). ICU admission had marginally statistical association with one-year survival in propensity score adjusted multivariable analysis (HR 0.49 95% CI 0.23–1.06).

Subgroup analysis showed improved in-hospital survival among patients who were admitted to ICU among all subgroups accept for those who were admitted with cardiac primary diagnosis and those with dementia (Table 1 in the appendix).

Table 2
ICU bed occupancy (in quartiles) and its association with ICU acceptance, in-hospital mortality, and hospital length of stay of patients treated in the RR.

ICU beds vacant		Q1	Q2	Q3	Q4	P value
Unit destination	Ward (%)	181 (60.9)	154 (57.2)	63 (55.8)	136 (67.3)	0.101
	ICU (%)	116 (39.1)	115 (42.8)	50 (44.2)	66 (32.7)	
In-hospital mortality	Died (%)	135 (45.5)	131 (48.7)	47 (41.6)	87 (43.1)	0.515
Length of hospitalization	Days (IQR)	5.0 (3.0–10.5)	6.0 (2.0–14.0)	6.0 (2.5–15.5)	9.0 (3.5–17.0)	0.163

RR – Resuscitation room, IQR – Interquartile range.

Table 3
Logistic regression for ICU admission.

Variable	P value	OR	Lower 95% CI	Upper 95% CI
Age ≥ 80	<0.001	0.091	0.039	0.213
Female gender	0.006	0.445	0.249	0.797
Cardiac primary diagnosis	<0.001	5.075	2.736	9.412
Morning shift	0.020	0.489	0.267	0.894
Vassopressors in resuscitation room	0.003	3.237	1.485	7.055
ED visits within the previous 30 days	0.022	0.444	0.221	0.892

C-statistic = 0.751.

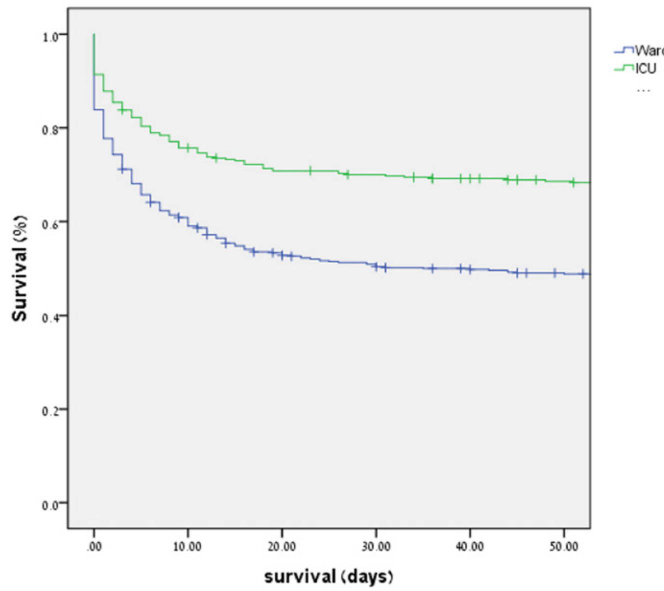

Fig. 2. Kaplan-Meier curve for in-hospital mortality among patients who were admitted from resuscitation room to ward vs. ICU ($p < 0.001$).

4. Discussion

In this study, we delineate the characteristics of critically-ill patients who were treated in the medical ED RR as well as the factors that are associated with ICU admission in the environment of ICU beds paucity. We found that ICU admissions were associated with increased in-hospital survival adjusted for the variety of patient characteristics and propensity score for ICU admission. This effect was also at least partially observed up to one year from admission among hospital survivors in the entire cohort as well as in a subgroup analysis.

In the current study, we present the demographics, clinical characteristics, admission pathways, and outcomes in the heterogeneous group of RR all-comers. These patients are “the sickest of sick” among ED admissions, as they are commonly transferred after receiving initial resuscitation to ICU. Previously, only a small number of studies in ED patients have specifically addressed this subpopulation [20-22]. Moreover, these studies have focused on the outcome of only specific diagnoses among RR patients. For example, early recognition of septic patients or those with community-acquired pneumonia among this population, was found to be associated with higher in-hospital survival rate [23, 24]. Similarly, early transfer to ICU was associated with survival benefits for patients admitted to the ED with acute stroke, myocardial infarction or for oncological patients [25-27].

In our cohort of critically-ill patients the minority of treatments (40%) resulted in an admission to an ICU. We showed specific characteristics that were associated with increased chances of ICU admission such as younger age, cardiac event, and vasopressor RR treatment. However, female gender, admission during the morning shift and recent ED encounters were associated with lower chances of ICU admission. Although a number of previous studies have described these parameters as being associated with the decision on ICU admission, those studies were conducted in health systems with relatively high ICU beds availability and “open doors” policy compared to the restricted ICU capacity and “closed doors” policy in the settings of this study [13,28-30].

The availability of ICU beds varies across regions and countries, as do the number of admissions: for instance, adult ICU beds ranged five-fold from 5.0/100,000 population in the UK to 24.0/100,000 in Germany and the volume of ICU admissions per year varied ten-fold from 216/100,000 population in the UK to 2353/100,000 in Germany [31,32]. In SUMC, the ICU beds constitute only 2.9% of total general beds and there are only 2.3 ICU beds per 100,000 capita in the region. The low ICU bed availability was reported to be correlated with lower ICU acceptance and higher mortality rates, which may explain the findings in our cohort [33-35]. On the other hand, temporal relative availability of ICU beds was not associated with increased odds of ICU admission or lower in-hospital mortality. Due to the low ICU beds availability in Israel, a restrictive ICU acceptance policy is in effect. It is obvious that patient mix is very different between critically-ill patients with and without ICU admission. We can hypothesize that an environment with low ICU beds capacity forces the intensivists to choose those who could “benefit” from treatment in the ICU the most. In our study, younger

Table 4
Length of hospitalization, crude mortality and landmark analysis.

Group	Admission to ICU n = 371	Admission to ward n = 558	P value
Length of hospitalization (days)	7 (4,15)	5 (2,13)	**<0.001**
Hospital discharge destination/status			**<0.001**
Home	236 (63.8%)	249 (44.6%)	
Death	120 (32.4%)	290 (52.0%)	
Facility	14 (3.8%)	19 (3.4%)	
24-h mortality	34 (9.8%)	88 (16.4%)	**0.007**
7-days mortality	73 (21.0%)	197 (36.6%)	**<0.001**
Landmark analysis[a]			
30-days mortality following hospital discharge	14 (5.6%)	18 (6.7%)	0.605
60-days mortality following hospital discharge	22 (8.8%)	27 (10.0%)	0.155
180-days mortality following hospital discharge	31 (12.4%)	55 (20.4%)	**0.012**
365-days mortality following hospital discharge	45 (18.0%)	84 (31.2%)	**<0.001**
ED visit in 60 days following hospital discharge	78 (31.2%)	99 (36.8%)	0.178

RR – Resuscitation room, ED – Emergency department.
Bold indicate Significance level < .05.
[a] P values for landmark analysis were calculated using log-rank.

Table 5
Propensity score matched logistic regression for in-hospital mortality.

Variable	P value	OR	Lower 95% CI	Upper 95% CI
Sudden cardiac death	0.003	3.169	1.487	6.755
CCI > 2	<0.001	3.035	1.793	5.137
pH < 7.1	0.001	3.113	1.580	6.132
Platelets < 150	0.014	2.796	1.232	6.346
ICU admission	<0.001	0.355	0.206	0.612

C-statistic = 0.748.
CCI - Charlson's comorbidity index, ICU – Intensive care unit.

Table 6
Propensity score matched landmark analysis for one-year mortality.

Variable	P value	RR	Lower 95% CI	Upper 95% CI
Age ≥ 80	0.104	2.461	0.830	7.299
Albumin	0.001	0.356	0.194	0.652
Creatinine > 1.2	0.014	2.802	1.228	6.389
ED visits within the previous 30 days	0.078	2.182	0.916	5.196
ICU admission	0.071	0.497	0.232	1.062

ED - Emergency department, ICU – Intensive care unit.

and healthier critically-ill patients had higher chances to be admitted to ICU.

We found that advanced age decreases the chance for ICU admission. The elderly represent an increasing subgroup of patients admitted to ICU who may be at risk of worse outcomes due to their age, although other factors (e.g. comorbidities and functional impairment) seem to have greater influence on their survival [36-38]. In the reality of paucity of ICU beds we demonstrated only 10% of ICU admission among RR critically-ill patients older than 80, whereas almost 40% of this group were admitted to a general ward instead. Our results suggest lower ICU admission rate for critically-ill octogenarian patients than was previously reported [39]. In addition to advanced age, poor cognitive and functional status was also reported with lower ICU admission rate in health systems which operates ICU's with "open doors" policy [7,40]. Our findings that older patients and those with dementia show lower ICU admission rate in an ICU with "closed doors" policy are also consistent with this literature. Although the decision which patient should be admitted to ICU based on clinical judgment, it is reasonable to assume that in a restrictive ICU environment there is lower chance to admit patient with advanced age and poor functional status to ICU. In addition, there was a relatively low number of patients in our cohort diagnosed with dementia (2 admitted to ICU and 35 admitted to non-ICU), which prevents us from conducting a more thorough analysis of this issue.

The in-hospital mortality rate of our cohort was high: 32.4% for ICU admitted patients and 52% for critically-ill non-ICU patients. Moreover, the one-year mortality was 44% for ICU admitted patients compared with 66% for those who were not in uni-variate analysis. However, we found that among propensity score matched hospital survivors (landmark analysis), ICU admission was not associated with higher survival rate one year from discharge. Previous studies reported lower short-term mortality (in-hospital or 30-day) in the range of 15% for septic patients to 45% for cancer patients [41-43]. However, these studies took place in ICUs with "open door" policy compared to the relatively low availability and "closed door" policy in Israel in general and in this study's setting in particular.

Our results of a propensity score matched analysis show that there was marginally significant positive effect of ICU admission on long term survival. Yet, we can't exclude the possibility of the biased estimate. A restricted ICU admission ("closed doors") environment with a rigorous patient selection process could have led to two opposing biases. The first bias is driven by the selection of patients with ostensibly better chance to gain from the limited resource of ICU, e.g. younger and healthier patients with better overall prognosis. The second bias is driven by admitting to the ICU "the sickest of sick", meaning those who need the ICU the most. While the former may contributes to improved short and long term survival of ICU, the later has opposite effect. We believe that since the source cohort (patient undergoing resuscitation in ED) comprises very sick patients, that the selection of the "healthier patients" is the cause of the main bias contributing the better survival of ICU admitted patients.

This study has several limitations. First, this study is of an observational nature and cannot establish causality between non-ICU admission and critically ill patients mortality. Second, we could not obtain data regarding the functional status or severity index (e.g., SOFA score), both important predictors for ICU acceptance and survival. Third, we did not have an assessment of how many patients were actually presented to the ICU. However, based on familiarity with common practices in SUMC, we assume that the majority of the RR patients were indeed presented to an ICU.

Notwithstanding these limitations, we have characterized the critically-ill medical ED patients treated in the RR. In the environment of limited ICU bed availability, we have demonstrated the effect of the initial "the sickest of sick" patient characteristics not only on the disposition decision, but also on their survival. Our results pointed that patient selection when ICU beds are limited seems to be at least partially successful, as it is associated with better short and perhaps long term clinical outcomes.

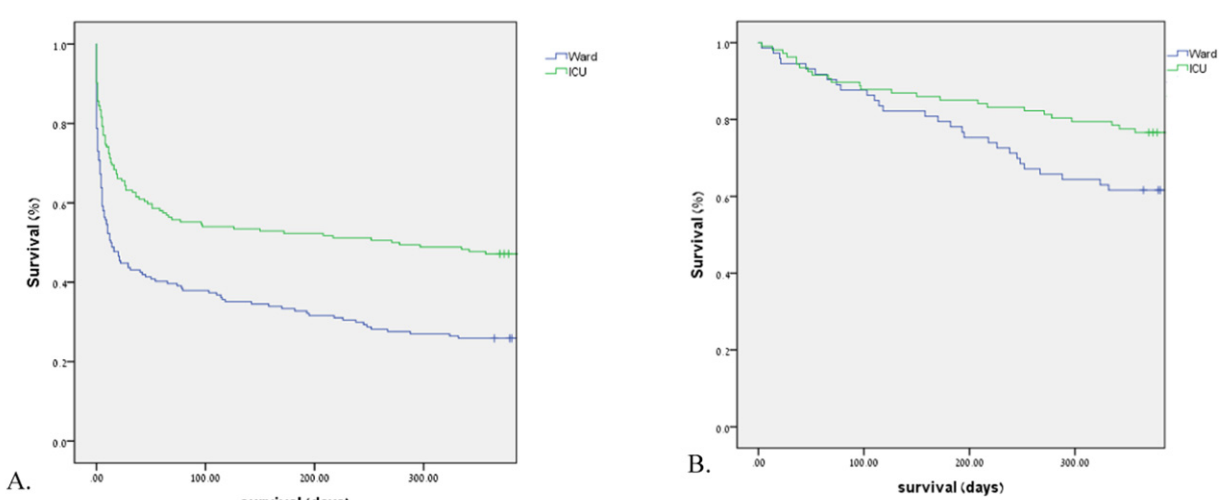

Fig. 3. Kaplan-Meier curves for propensity score matched (1:1) one-year mortality among patients who were admitted from resuscitation room to ward vs. ICU. Panel A represents the entire cohort and panel B represents the landmark analysis for patients who survived the index hospitalization ($p < 0.001$ and $p = 0.03$ respectively).

Appendix A

Table 1
Logistic regression for in-hospital mortality among patients who admitted to ICU[a] after admission from resuscitation room – subgroups analysis.

Variable	*P* value	OR	Lower 95% C·I	Upper 95% C·I
Age ≥ 70	<0.001	0.355	0.209	0.603
Age < 70	<0.001	0.354	0.206	0.608
Male gender	<0.001	0.298	0.185	0.481
Female gender	<0.001	0.345	0.194	0.615
CCI ≤ 2	<0.001	0.349	0.207	0.588
CCI > 2	<0.001	0.297	0.180	0.489
Diabetes	0.001	0.352	0.190	0.654
No diabetes	<0.001	0.298	0.191	0.466
First albumin > 3	<0.001	0.365	0.299	0.581
First albumin ≤ 3	0.018	0.428	0.212	0.865
Cardiac primary diagnosis	0.407	0.755	0.389	1.466
Non-cardiac primary diagnosis	<0.001	0.280	0.176	0.444

Results are adjusted for sudden cardiac death, pH < 7.1, platelets <150, CCI > 2.
CCI - Charlson's comorbidity index.
[a] Reference is non-ICU admissions.

References

[1] Hall RE, Jones CI. The value of life and the rise in health spending. Q J Econ 2007; 122(1):39–72.
[2] Tang N, Stein J, Hsia RY, Maselli JH, Gonzales R. Trends and characteristics of US emergency department visits, 1997–2007. American Medical Association]–>JAMA 2010;304(6):664–70.
[3] Schuur JD, Venkatesh AK. The growing role of emergency departments in hospital admissions. N Engl J Med 2012;367(5):391–3.
[4] Pines JM, Mullins PM, Cooper JK, Feng LB, Roth KE. National trends in emergency department use, care patterns, and quality of care of older adults in the United States. J Am Geriatr Soc 2013;61(1):12–7.
[5] Simchen E, Sprung CL, Galai N, Zitser-Gurevich Y, Bar-Lavi Y, Levi L, et al. Survival of critically ill patients hospitalized in and out of intensive care. Crit Care Med 2007 Feb;35(2):449–57.
[6] Simchen E, Sprung CL, Galai N, Zitser-Gurevich Y, Bar-Lavi Y, Gurman G, et al. Survival of critically ill patients hospitalized in and out of intensive care units under paucity of intensive care unit beds. Crit Care Med 2004;32(8):1654–61.
[7] Sprung CL, Artigas A, Kesecioglu J, Pezzi A, Wiis J, Pirracchio R, et al. The Eldicus prospective, observational study of triage decision making in European intensive care units. Part II: intensive care benefit for the elderly. Crit Care Med 2012 Jan;40(1): 132–8.
[8] Sprung CL, Baras M, Iapichino G, Kesecioglu J, Lippert A, Hargreaves C, et al. The Eldicus prospective, observational study of triage decision making in European intensive care units: part I–European Intensive Care Admission Triage Scores. Crit Care Med 2012 Jan;40(1):125–31.
[9] Politi L, Codish S, Sagy I, Fink L. Use patterns of health information exchange systems and admission decisions: reductionistic and configurational approaches. Int J Med Inform 2015;84(12):1029–38.
[10] Lyons RA, Wareham K, Hutchings HA, Major E, Ferguson B. Population requirement for adult critical-care beds: a prospective quantitative and qualitative study. Lancet 2000;355(9204):595–8.
[11] Gooch RA, Kahn JM. ICU bed supply, utilization, and health care spending: an example of demand elasticity. JAMA 2014;311(6):567–8.
[12] Knesset Israeli. Low beds capacity in intensive care units in the Israeli health system: a report to the work, welfare and health committee; February 2007Available at: www.news1.co.il/uploadFiles/44277369976044.doc. Accessed May 2017.
[13] Garrouste-Orgeas M, Montuclard L, Timsit J, Reignier J, Desmettre T, Karoubi P, et al. Predictors of intensive care unit refusal in French intensive care units: a multiple-center study. Crit Care Med 2005;33(4):750–5.
[14] Molina JA, Seow E, Heng BH, Chong WF, Ho B. Outcomes of direct and indirect medical intensive care unit admissions from the emergency department of an acute care hospital: a retrospective cohort study. BMJ Open 2014 Nov 27;4(11):e005553 [-2014-005553].
[15] Chalfin DB, Trzeciak S, Likourezos A, Baumann BM, Dellinger RP. DELAY-ED study group. Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. Crit Care Med 2007 Jun;35(6): 1477–83.
[16] Chang YT, Chen CC, Chang CY, Kuo YC. Evaluation of unpredictable critical conditions of patients treated in the observation unit of the Emergency Department. J Emerg Med 2004;27(2):109–13.
[17] Peral-Rodriguez R, Estevez-Gonzalez F, Garcia-Montoya L. The most common causes of admission and related variables in the resuscitation room of the emergency service. Enferm Clin 2009 May-Jun;19(3):136–40.
[18] Bernhard M, Becker TK, Nowe T, Mohorovicic M, Sikinger M, Brenner T, et al. Introduction of a treatment algorithm can improve the early management of emergency patients in the resuscitation room. Resuscitation 2007;73(3):362–73.
[19] Fuchs L, Anstey M, Feng M, Toledano R, Kogan S, Howell MD, et al. Quantifying the mortality impact of do-not-resuscitate orders in the ICU. Crit Care Med 2017 Jun; 45(6):1019–27.
[20] Cattermole GN, Mak SP, Liow CE, Ho MF, Hung KYG, Keung KM, et al. Derivation of a prognostic score for identifying critically ill patients in an emergency department resuscitation room. Resuscitation 2009;80(9):1000–5.
[21] Chang Y, Chen C, Chang C, Kuo Y. Evaluation of unpredictable critical conditions of patients treated in the observation unit of the emergency department. J Emerg Med 2004;27(2):109–13.
[22] Bernhard M, Becker TK, Nowe T, Mohorovicic M, Sikinger M, Brenner T, et al. Introduction of a treatment algorithm can improve the early management of emergency patients in the resuscitation room. Resuscitation 2007;73(3):362–73.
[23] Freund Y, Lemachatti N, Krastinova E, Van Laer M, Claessens Y, Avondo A, et al. Prognostic accuracy of sepsis-3 criteria for in-hospital mortality among patients with suspected infection presenting to the emergency department. JAMA 2017;317(3): 301–8.
[24] Renaud B, Santin A, Coma E, Camus N, Van Pelt D, Hayon J, et al. Association between timing of intensive care unit admission and outcomes for emergency department patients with community-acquired pneumonia. Crit Care Med 2009 Nov;37(11): 2867–74.
[25] Gibson CM, Pride YB, Frederick PD, Pollack CV, Canto JG, Tiefenbrunn AJ, et al. Trends in reperfusion strategies, door-to-needle and door-to-balloon times, and in-hospital mortality among patients with ST-segment elevation myocardial infarction enrolled in the National Registry of Myocardial Infarction from 1990 to 2006. Am Heart J 2008;156(6):1035–44.
[26] Rincon F, Mayer SA, Rivolta J, Stillman J, Boden-Albala B, Elkind MS, et al. Impact of delayed transfer of critically ill stroke patients from the Emergency Department to the Neuro-ICU. Neurocrit Care 2010;13(1):75–81.
[27] Soares M, Caruso P, Silva E, Teles JM, Lobo SM, Friedman G, et al. Characteristics and outcomes of patients with cancer requiring admission to intensive care units: a prospective multicenter study. Crit Care Med 2010 Jan;38(1):9–15.
[28] Sprung CL, Geber D, Eidelman LA, Baras M, Pizov R, Nimrod A, et al. Evaluation of triage decisions for intensive care admission. Crit Care Med 1999;27(6):1073–9.
[29] Escher M, Perneger TV, Chevrolet JC. National questionnaire survey on what influences doctors' decisions about admission to intensive care. BMJ 2004 Aug 21; 329(7463):425.
[30] Sinuff T, Kahnamoui K, Cook DJ, Luce JM, Levy MM. Rationing critical care beds: a systematic review. Crit Care Med 2004;32(7):1588–97.
[31] Murthy S, Leligdowicz A, Adhikari NK. Intensive care unit capacity in low-income countries: a systematic review. PLoS One 2015;10(1):e0116949.
[32] Wunsch H, Angus DC, Harrison DA, Collange O, Fowler R, Hoste EA, et al. Variation in critical care services across North America and Western Europe. Crit Care Med 2008 Oct;36(10):2787–93 [e1-9].
[33] Khalid I, Qabajah MR, Hamad WJ, Khalid TJ, DiGiovine B. Outcome of hypotensive ward patients who re-deteriorate after initial stabilization by the Medical Emergency Team. J Crit Care 2014;29(1):54–9.
[34] Flabouris A, Jeyadoss J, Field J, Soulsby T. Direct and delayed admission to an intensive care or high dependency unit following discharge from the emergency department: associated patient characteristics and hospital outcomes. Crit Care Resusc 2012;14(3):191.
[35] Bing-Hua Y. Delayed admission to intensive care unit for critically surgical patients is associated with increased mortality. Am J Surg 2014;208(2):268–74.
[36] Bagshaw SM, Webb SA, Delaney A, George C, Pilcher D, Hart GK, et al. Very old patients admitted to intensive care in Australia and New Zealand: a multi-centre cohort analysis. Crit Care 2009;13(2):R45.
[37] Lerolle N, Trinquart L, Bornstain C, Tadie JM, Imbert A, Diehl JL, et al. Increased intensity of treatment and decreased mortality in elderly patients in an intensive care unit over a decade. Crit Care Med 2010 Jan;38(1):59–64.
[38] Boumendil A, Somme D, Garrouste-Orgeas M, Guidet B. Should elderly patients be admitted to the intensive care unit? Intensive Care Med 2007;33(7):1252.
[39] Garrouste-Orgeas M, Timsit J, Montuclard L, Colvez A, Gattolliat O, Philippart F, et al. Decision-making process, outcome, and 1-year quality of life of octogenarians referred for intensive care unit admission. Intensive Care Med 2006:32(7).

[40] Garrouste-Orgeas M, Boumendil A, Pateron D, Aergerter P, Somme D, Simon T, et al. Selection of intensive care unit admission criteria for patients aged 80 years and over and compliance of emergency and intensive care unit physicians with the selected criteria: an observational, multicenter, prospective study. Crit Care Med 2009; 37(11):2919–28.
[41] Raith EP, Udy AA, Bailey M, McGloughlin S, MacIsaac C, Bellomo R, et al. Prognostic accuracy of the SOFA score, SIRS criteria, and qSOFA score for in-hospital mortality among adults with suspected infection admitted to the intensive care unit. JAMA 2017;317(3):290–300.
[42] Thiéry G, Azoulay É, Darmon M, Ciroldi M, De Miranda S, Lévy V, et al. Outcome of cancer patients considered for intensive care unit admission: a hospital-wide prospective study. J Clin Oncol 2005;23(19):4406–13.
[43] Liu V, Lei X, Prescott HC, Kipnis P, Iwashyna TJ, Escobar GJ. Hospital readmission and healthcare utilization following sepsis in community settings. J Hosp Med 2014; 9(8):502–7.