The Intensive Care Outcome of Patients with a Solid Malignancy in a Tertiary Hospital in Saudi Arabia: A prospective Intensive Care Unit Registry Study

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Research

Keywords: Solid Tumor, Solid Malignancy, ICU mortality, ICU Prolonged Stay

Posted Date: September 9th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-63526/v1

Abstract

Aim: There is a paucity of research on the factors predicting mortality and prolonged stay in the Intensive Care Unit (ICU) in critically ill patients with a solid malignancy. We aimed to assess the characteristics and outcomes of these patients who admitted to a medical ICU in a tertiary hospital in Saudi Arabia, and determine the predictors of ICU mortality and ICU prolonged stay.

Method: Clinical data from patients with solid tumors extracted from a comprehensive prospective ICU registry. We used logistic regression analysis to identify the predictors influencing ICU mortality and ICU prolonged stay.

Results: Of 2883 patients admitted to the ICU, 364 patients identified with solid tumor were enrolled in this study. The most common solid tumor types were: breast (15.9%), colorectal (11.5%) and lung (9.9%) cancers. The ICU mortality rate was (32.4%), and there were 50 (13.7%) patients had a prolonged stay of ≥ 21 days. In the multivariate analysis, three factors were the independent predictors for the ICU mortality: Sequential Organ Failure Assessment (SOFA) score (P <.001), mechanical ventilation (P=.004) and inotropic/vasopressor agents (P=.018), and four variables were independent predictors for the prolonged stay in ICU: ICU acquired infection (P<.001), SOFA score (P <.001), mechanical ventilation (P<.001) and bilirubin (P=.049).

Conclusion: In patients with solid tumour the ICU mortality is 32.4%, and 13.7% had a prolonged ICU stay. The reported outcome in this study indicate benefit from ICU care in this category of cases The identified predictors of ICU mortality and prolonged stay of patients would help in assessing the potential benefit of ICU admission, and prognostication.

Background:

Significant medical advances have been made in the field of cancer management that resulted in dramatic improvement of patients' outcomes and survival, and associated with increasing demand for intensive care unit admissions and treatment (1–3). Recent studies have reported that there has been a significant improvement in the Intensive Care Unit (ICU) survival rate in cancer patients (1–7). This improvement in ICU survival of cancer patients led many investigators to look for factors influencing the ICU mortality in order to guide cancer critically ill patients case selection for ICU admission, who could benefit from critical care management strategies (1, 4–7). While many published studies focused on either the predictors of ICU mortality of cancer patients in general or in patients with hematological malignancies, a very little researches have been conducted on patients with solid tumors, although the critical care outcome-predictors still controversial in such patients' category. Moreover, it seems that no study investigated such an outcome in these patient's category in Saudi Arabia.

Although many critically ill patients are admitted to the ICU for a short period, it is not uncommon that some patients have a complicated clinical course, and require a Prolonged Length of Stay (LOS) in ICU. The long ICU stay expose patients to an increasing risk of many complications that might have undesired

effect on the health that could lead to mortality (8, 9). Also, the long ICU stay have an impact on ICU bed availability for new cases and a subsequent delayed ICU admission. Delayed admission to ICU is a known factor associated with worse patient outcomes (10–12). Thus, knowledge of factors predicting prolonged ICU stay is important in improving the ICU care, as well as, guide better resources utilization. There are limited data on the ICU outcomes and predictors of prolonged stay for patients with solid tumors. To our knowledge, no research has explored the characteristics of these patients. Therefore, we aimed to describe the characteristics and outcomes of critical care patients with solid tumors, to determine the predictors of mortality and prolonged stay in ICU.

Methodology:

Study Design:

This is a prospective registry study conducted in the medical ICU of King Abdullah Medical City, a 500-bed tertiary hospital, in Makkah, Saudi Arabia. We extracted the patients' data between May 2015 and July 2018 from a prospective ICU database, a comprehensive ICU registry (13) that collects data on ICU patient's characteristics, procedures, treatments and outcomes. Data collection was carried out by experienced ICU physicians, and immediate data entry was obligatory in order to obtain high quality data. We extracted the following data: age, gender, cancer type, cancer characteristics (e.g., course of malignancy, staging and treatment), comorbidities, reasons for ICU admission, source of ICU admission, LOS at hospital prior to ICU admission, laboratory results, infection acquired at the ICU admission and during ICU stay, Sequential Organ Failure Assessment (SOFA) score, Acute physiology and Chronic Health Evaluation (APACHE II) score, therapeutic interventions during ICU stay and ICU mortality rate.

Study Sample:

In order to avoid the assessment of multiple ICU outcomes for a single patient, only the first ICU admission was counted in this study. All patients admitted to ICU with age above 14 years been diagnosed with solid tumor were included in this study. In order to ensure that the study population are sick enough to be certainly in need for active ICU management (Fig. 1), we excluded patients with hematological malignancy, patients discharged from ICU within 24 hrs. from admission, cancer patients admitted routinely after elective surgeries, and patients have Do Not Resuscitate (DNR) order within 48 hrs. of ICU admission. The primary outcomes of the study were ICU mortality and the ICU LOS while the secondary outcomes were the predictors of mortality and prolonged stay in ICU. This study defined as an ICU stay **≥ 21 days** (9).

Statistical Analysis:

We imported the data from the registry system into SPSS version 23. Discrete variables were reported using counts and percentages while continuous variables using the mean and standard deviation. We evaluated differences between the ICU outcomes (survivors - non-survivors and non-prolonged - prolonged stay) using the t test or Mann-Whitney U test for continuous variables, and the $\chi 2$ test or Fisher

exact test for categorical variables. Patients with prolonged ICU stay compared to patients surviving 21 days after ICU admission who were no longer staying in the ICU. In the non-prolonged ICU stay, we excluded 91 patients who died before 21 days. Multivariate logistic regression analyses were used to determine the predictors of ICU mortality and ICU prolonged stay. Only statistically significant factors ($P < .05$) on a univariate basis were introduced in the multivariate analysis.

Results:

Patient Characteristics:

A mong the total 2883 patients admitted to the ICU during the research period, 364 (14.2%) patients admitted to ICU identified with solid tumours, who are enrolled in the study. Table 1 summarises the characteristics and outcomes of these patients. Mean age was 57.6 years and nearly half the patients were female (48.9%). It is found that 264 (72.5%) of the study population had progressive disease and 158 (43.4%) with confirmed metastatic cancer. The most frequent sites of metastasis were liver (18.7%), lung (17.9%) and bone (17%). The most common solid tumors were breast (16.6%), colorectal (11.5%) and lung (9.9%) cancers. We found that 295 (81%) patients was on active cancer treatment, 126 (34.6%) patients were being treated on chemotherapy, 75 (20.6%) patients on radiation therapy, 60 patients (16.5%) on biological therapy and 34 patients (9.3%) on hormonal therapy. The most common comorbidities are hypertension (41.5%), diabetes (35.7%) and cardiovascular disease (23%). Although the most frequent reasons for ICU admission were respiratory failure (52.7%) and sepsis (52.2%), two or more organs dysfunctions were found in 148 patients (40.7%) with the most common organs found to be dysfunction was pulmonary and cardiovascular dysfunction. Furthermore, the SOFA score was 6.9 ± 4.7, whereas APACHE II score was 19.8 ± 8.4.

Table 1
Baseline characteristics and outcomes

Variable	Patients with Solid Tumor (n = 364)
Age at ICU admission	57.6 ± 15.8
Mean ± SD	59 (47–70.7)
Median (IQR)	
Gender	186 (51.1%)
Male	178 (48.9%)
Female	
Course of malignancy	264 (72.5%)
Progressive	100 (27.5%)
Not progressive	
Staging	158 (43.4%)
Metastatic	206 (56.6%)
Non Metastatic	
Site of metastasis	68 (18.7%)
Liver	65 (17.9%)
Lung	62 (17%)
Bone	18 (4.9%)
Peritoneal	40 (10.9%)
Others	

Continued, Table 1 Baseline characteristics and outcomes

Variable	Patients with Solid Tumor (n = 364)
Types of cancer	58 (15.9%)
Breast	42 (11.5%)
Colorectal	36 (9.9%)
Lung	24 (6.5%)
Oral	23 (6.3%)
Upper GIT	22 (6%)
gynecological	19 (5.2%)
Pancreas	18 (4.9%)
Brain	15 (4.1%)
Thyroid	15 (4.1%)
Prostate	12 (3.2%)
Renal cell carcinoma	11 (3%)
Hepatobiliary	10 (2.7%)
Gall bladder	
Variable	**Patients with Solid Tumor (n = 364)**
Ovary	9 (2.4%)
Bladder	11 (3%)
Others	
Active cancer treatment	126 (34.6%)
Chemotherapy	
Biologic	60 (16.5%)
Hormonal	34 (9.3%)
Radiation	75 (20.6%)

Continued, Table 1 Baseline characteristics and outcomes

Variable	Patients with Solid Tumor (n = 364)
Source of admission	157 (43.1%)
ER	207 (56.9%)
Non-ER	
LOS at hospital prior to ICU admission	4.9 ± 16.7
Mean ± SD	1 (0–5)
Median (IQR)	
Comorbidities	130 (35.7%)
Diabetes mellitus	
Hypertension	151 (41.5%)
Cardiovascular diseases	84 (23.1%)
Reason of ICU admission	192 (52.7%)
Respiratory failure	
Sepsis/septic shock	190 (52.2%)
Neurological disorder	77 (21.2%)
Renal dysfunction	47 (12.9%)
Hepatic dysfunction	20 (5.5%)
Coagulopathy	15 (4.1%)
≥ 2 organ dysfunctions	148 (40.7%)
ICU admission microbiology	130 (35.7%)
Admission culture	
Bacterial infection	125 (34.3%)
Fungal infection	14 (3.8%)
Bloodstream infection	75 (20.6%)
Lung infection	35 (9.6%)
Urine infection	35 (9.6%)
Continued, Table 1 Baseline characteristics and outcomes	

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Variable	Patients with Solid Tumor (n = 364)
Variable	**Patients with Solid Tumor (n = 364)**
On ICU admission	19.8 ± 8.4
APACHE II	18 (14–26)
Mean ± SD	
Median (IQR)	
SOFA	6.9 ± 4.7
Mean ± SD	6 (3–10)
Median (IQR)	
Laboratory results	11.3 ± 8.1
WBC	9.9 (5.9–14.6)
Mean ± SD	
Median (IQR)	
Platelet	237.2 ± 151.9
Mean ± SD	215 (130–323.5)
Median (IQR)	
Hemoglobin	9.7 ± 2.4
Mean ± SD	9.5 (7.9–11.3)
Median (IQR)	
ALT	69.4 ± 207.9
Mean ± SD	27 (16–51)
Median (IQR)	
AST	147.6 ± 551.4
Mean ± SD	33 (21–89.1)
Median (IQR)	

Continued, Table 1 Baseline characteristics and outcomes

Variable	Patients with Solid Tumor (n = 364)
Bilirubin *Mean ± SD* *Median (IQR)*	2.9 ± 22.8 0.7 (0.4–1.3)
Creatinine *Mean ± SD* *Median (IQR)*	1.7 ± 2.1 1 (0.7–1.9)
Calcium *Mean ± SD* *Median (IQR)*	10.6 ± 39.9 8.4 (7.6–9.2)
Continued, Table 1 Baseline characteristics and outcomes	
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Among 211 patients (57.9%) required mechanical ventilator (MV), 185 patients (50.8%) required invasive MV. The mean duration on mechanical ventilator is 11.8 ± 15.3 days and median of 6 days. Vasopressor agents were required in 182 (50%) patients, and 46 (12.6%) received renal replacement therapy. The ICU acquired infections were detected in 49 patients (13.5%). The mean ICU LOS was 11.4 ± 13.6 days and median of 6.4 days. They used a total of 4156 out of total 35367 ICU bed-days, accounting for 11.7% of the total ICU bed-days. Of the total patents,74 patients (20.5%) had DNR order. The ICU mortality was 32.4%, and hospital mortality was 47.3%.

Results of the survivors versus non-survivors of solid tumors patients:

Table 2 shows that non-survivors had significantly more progressive cancer and more likely to be admitted to the ICU due to sepsis / septic shock and respiratory failure. The APACHE II and SOFA scores were significantly higher in non-survivors than survivors. Of the laboratory results, aspartate Amino-Transferase (AST) level, bilirubin and creatinine were significantly higher in non-survivors. Non-survivors were more likely to require vasopressors, receive renal replacement therapy and mechanical ventilation. Having ICU-acquired infections were more common among non-survivors. Prior to ICU admission, non-survivors were hospitalised for a longer duration compared to survivors. We did not find any significant difference between survivors and non-survivors in age, gender, comorbidities, cancer staging, metastatic site, cancer treatment, haemoglobin level, whit cell count and platelet count.

Table 2
Characteristics of the survivor and non-survivor of patients with solid tumors

Variable	**Patients with Solid Tumor (n = 364)**
Serum Albumin	2.8 ± 1
Mean ± SD	2.7 (2–3.3)
Median (IQR)	
Leukopenia	54 (14.8%)
Thrombocytopenia	11 (3%)
During ICU stay	182 (50%)
Vasopressor use	
Renal replacement therapy	46 (12.6%)
Mechanical ventilation	211 (57.9%)
Invasive ventilation	185 (50.8%)
Non-invasive ventilation	26 (7.1%)
Duration of MV	11.8 ± 15.3
Mean ± SD	6 (2–14)
Median (IQR)	
Blood product transfusion	53 (14.6%)
Tracheostomy	53 (14.6%)
ICU acquired infections	49 (13.5%)
Bacterial infection	31 (8.5%)
Fungal infection	31 (8.5%)
Bloodstream infection	20 (5.5%)
Lung infection	27 (7.4%)
Urine infection	6 (1.6%)

Variable	Patients with Solid Tumor (n = 364)
Outcome	74 (20.5%)
DNR order	11.4 ± 13.6
ICU stay	6.4 (3.6–13.2)
Mean ± SD	118 (32.4%)
Median (IQR)	
ICU Mortality	
Hospital mortality	172 (47.3%)

Results of the solid tumors patients with prolonged and non-prolonged ICU stay:

Table 3 shows the results of the univariate analyses comparing patients had a prolonged and non-prolonged ICU stay. Patients admitted to ICU due to respiratory failure and having ≥ 2 organ dysfunctions were more likely to require a prolonged ICU stay. The APACHE II and SOFA scores were significantly higher among patients needed a prolonged ICU stay. Of the laboratory variables, only bilirubin and calcium were found to be significant between patients with a prolonged and non-prolonged ICU stay. Patients had a prolonged ICU stay were more likely to require vasopressors, renal replacement therapy and mechanical ventilation. ICU-acquired infections were significantly more common in patients with a prolonged ICU stay.

Table 3
Characteristics of the solid tumors patients with prolonged stay and non-prolonged stay

Variable	Survivor (n = 246)	Non-survivor (n = 118)	P-value
ALT	54.4 ± 105.5	100.6 ± 330.7	.115
Mean ± SD	26.5 (15.2–50.7)	29 (18.5–58.5)	
Median (IQR)			
AST	108.7 ± 316.4	228.5 ± 850.8	**< .001**
Mean ± SD	30 (20–67.7)	51.7 (24.5–134.5)	
Median (IQR			
Bilirubin	3.1 ± 27.5	2.6 ± 5.1	**.013**
Mean ± SD	0.6 (0.4–1.2)	0.7 (0.5–2.3)	
Median (IQR			
Creatinine	1.7 ± 2.3	1.9 ± 1.6	**.002**
Mean ± SD	0.9 (0.6–1.8)	1.1 (0.8–2.5)	
Median (IQR			
Calcium	11.7 ± 48.6	8.2 ± 1.2	**.042**
Mean ± SD	8.4 (7.8–9.3)	8.1 (7.5–9.1)	
Median (IQR			
Serum Albumin	2.9 ± 1	2.6 ± 1.1	**.004**
Mean ± SD	2.8 (2.1–3.3)	2.4 (1.7–3.2)	
Median (IQR)			
Leukopenia	33 (13.4%)	21 (17.8%)	.271
Thrombocytopenia	8 (3.3%)	3 (2.5%)	.498
During ICU stay	84 (34.1%)	98 (83.1%)	**< .001**
Vasopressor use			
Renal replacement therapy	22 (8.9%)	24 (20.3%)	**.002**
Mechanical ventilation	107 (45.3%)	101 (88.6%)	**< .001**
Invasive ventilation	82 (33.3%)	103 (87.3%)	**< .001**
Non-invasive ventilation	23 (9.3%)	3 (2.5%)	**.018**

Variable	Survivor (n = 246)	Non-survivor (n = 118)	P-value
Blood product transfusion	33 (13.4%)	20 (16.9%)	.371
Tracheostomy	26 (10.6%)	27 (22.9%)	**.002**
ICU acquired infection	22 (8.9%)	27 (22.9%)	**< .001**
Bacterial infection	14 (5.7%)	17 (14.4%)	**.005**
Fungal infection	14 (5.7%)	17 (14.4%)	**.005**
Bloodstream infection	6 (2.4%)	14 (11.9%)	**< .001**
Lung infection	15 (6.3%)	12 (10.7%)	.143
Urine infection	2 (0.8%)	4 (3.4%)	.090

Results of the multivariate analysis:

In the univariate analysis, we found that progressive cancer, LOS at hospital prior to ICU admission, respiratory failure and sepsis as reasons of ICU admissions, having 2 or more organs dysfunction, SOFA score, APACHE II score, some laboratory abnormalities (AST, bilirubin, and creatinine levels) and some therapeutic interventions (vasopressors, renal replacement therapy and mechanical ventilation) were significantly related to ICU mortality. However, we found only three factors independently predicting the ICU mortality: SOFA (OR,1.2; 95% CI, 1.1–1.3; P < .001), Mechanical ventilation (OR,3.8; 95% CI, 1.5–9.6; P = .004) and Vasopressor (OR,2.6; 95% CI, 1.1–5.9; P = .018) (Table 4).

Table 4
Independent predictors for ICU mortality

Variable	Non prolonged ICU stay (< 21 days) (n = 223)	Prolonged ICU stay (≥ 21 days) (n = 50)	P-value
ALT	56.4 ± 110.4	48.2 ± 104.9	.869
Mean ± SD	26 (15.5–51)	29 (14.5–44.5)	
Median (IQR)			
AST	115.2 *± 331.7*	64.8 *± 117.3*	.789
Mean ± SD	*29 (20–68)*	*31 (20–62.1)*	
Median (IQR)			
Bilirubin	3.3 *± 28.9*	0.9 *± 1.6*	**.045**
Mean ± SD	*0.6 (0.4–1.3)*	*0.5 (0.3–0.9)*	
Median (IQR)			
Creatinine	1.7 *± 2.4*	1.4 *± 1.5*	.322
Mean ± SD	*1 (0.7–1.8)*	*0.9 (0.6–1.6)*	
Median (IQR)			
Calcium	12 *± 51*	8.8 *± 1.1*	**.031**
Mean ± SD	*8.4 (7.7–9.2)*	*8.9 (8.1–9.6)*	
Median (IQR)			
Serum Albumin	2.9 *± 1*	2.6 *± 0.8*	.122
Mean ± SD	*2.8 (2.1–3.4)*	*2.7 (1.9–3.1)*	
Median (IQR)			
Leukopenia	29 (13%)	7 (14%)	.851
Thrombocytopenia	7 (3.1%)	3 (6%)	.330
Data During ICU stay	68 (30.5%)	38 (76%)	**< .001**
Vasopressor use			
Renal replacement therapy	15 (6.7%)	15 (30%)	**< .001**
Mechanical ventilation	84 (37.6%)	44 (88%)	**< .001**
Invasive ventilation	60 (26.9%)	47 (94%)	**< .001**

Variable	Non prolonged ICU stay (< 21 days) (n = 223)	Prolonged ICU stay (≥ 21 days) (n = 50)	P-value
Non-invasive ventilation	22 (9.9%)	2 (4%)	.270
Blood product transfusion	27 (12.1%)	11 (22%)	.068
Tracheostomy	10 (4.5%)	35 (70%)	**< .001**
ICU acquired infection	8 (3.6%)	33 (66%)	**< .001**
Bacterial infection	5 (2.2%)	20 (40%)	**< .001**
Fungal infection	5(2.2%)	20 (40%)	**< .001**
Bloodstream infection	0 (0%)	17 (34%)	**< .001**
Urine infection	1 (0.4%)	5 (10%)	**.001**

We also evaluated the factors influencing the prolonged ICU in the univariate analysis. We found that respiratory failure as a reason for ICU admission, having 2 or more organs dysfunction, ICU acquired infection, SOFA score, APACHE II score and some therapeutic interventions (vasopressors, renal replacement therapy, and mechanical ventilation) significantly related to the prolonged stay in ICU. However, only four variables were independent factors in predicting the prolonged stay in ICU: ICU acquired infection (odds ratio [OR],18.9; 95% CI, 5.3–66.7; P = < .001), SOFA (OR,1.5; 95% CI, 1.2–1.8; P = < .001), Mechanical ventilation (OR,8.9; 95% CI, 3–26.7; P = < .001), Bilirubin (OR, .5; 95% CI, .2 – .9; P = .049) (Table 5).

Table 5
Independent predictors prolonged LOS in ICU

Variable	OR (95% CI)	P-value
SOFA	1.2 (1.1–1.3)	**< .001**
Mechanical ventilation	3.8 (1.5–9.6)	**.004**
Vasopressor	2.6 (1.1–5.9)	**.018**
Variable	**OR (95% CI)**	**P-value**
ICU acquired infection	18.9 (5.3–66.7)	**< .001**
SOFA	1.5 (1.2–1.8)	**< .001**
Mechanical ventilation	8.9 (3–26.7)	**< .001**
Bilirubin	.5 (.2 –.9)	**.049**

Discussion:

There is little research about the factors predicting mortality and prolonged stay in ICU in critically ill patients with solid tumors, and it seems that no study in Saudi Arabia identified the factors influencing these outcomes in this subgroup. Knowledge on such factors is important in making appropriate patients' selection and improving the quality of ICU in these patients. Thus, the main objectives of this study were to determine the characteristics and the outcomes of patients with solid tumors admitted to ICU in a tertiary hospital in Saudi Arabia, and to explore factors affecting mortality and prolonged stay in ICU.

Our ICU mortality in patients with solid malignancies was 32.4% which is higher than our overall ICU mortality 19.2%. Previous research in patients with solid tumors reported large variation (15% – 59%) in the ICU mortality rates with an average rate of 31.2% (7, 14–16). A possible explanation of this large variation is the characteristics of patient's selection in those studies, the underlying malignancy (cancer type, course of malignancy, staging and treatment), causes of ICU admission and discharge, and therapeutic intervention decisions (1, 4–7, 17–19) as well as early DNR decisions that prevent ICU admissions of cases who will not benefit from ICU care. Our ICU mortality rate is slightly higher than the average rate reported in the previous research in patients with solid malignancy, and this might be explained by the composition of underlying malignancy in our patient's population as the rate of metastatic cancer (43.4%) and the majority had progressive disease (72.5%).

Studies of patients with a solid malignancy reported that predicting ICU mortality with adequate details is needed to be of prognostic value to physicians and for proper selection of cases for ICU care (14, 16). We found many factors associated with ICU mortality (Table 2). However, only 3 independent risk factors were found to be predicting ICU mortality rate in multivariate analysis. These factors were SOFA score at ICU admission, use of mechanical ventilation and vasopressor. These predictors have been similar to those reported in cancer patients (7, 20). Although the severity of the acute illness score (APACHE II) reported to be a main predictor factor for the ICU mortality in non-cancer patients (7), both organ failure (SOFA) and severity of the acute illness (APACHE II) scores are useful in predicting ICU mortality in cancer patients generally (20–22). However, in accordance with the study done by Aygencel et al. (7), we demonstrated that only organ failure score (SOFA) was independent risk factor for the ICU mortality in patients with solid tumors. Although we found that the course and stage of malignancy related to ICU mortality, these results were not significant predictors for ICU mortality. The impact of the stage of malignancy, response to chemotherapy and other characteristics of cancer on short-term outcome remain controversial. Some studies have reported these characteristics affect ICU mortality (6, 17, 23, 24) while others reported little or no impact on such an outcome (7).

To our knowledge, this is the first research investigating prolonged ICU stay in patients with solid malignancies. Of the total patients, 13.7% had an ICU stay of 21 days or more days. Prolonged ICU stay is a known to be associate an increased risk of severe complications that could lead to mortality. In this study, during ICU admission 66% of the patients with prolonged ICU stay developed ICU acquired infections. In our univariate analysis, we found that several factors were related to prolonged ICU stay

However, this study only identified 4 predictors to be significantly related to prolonged ICU stay. The independent predictors are presence of ICU acquired infections, SOFA score within 24 hrs of ICU admission, use of mechanical ventilation and bilirubin levels. These results confirm what been reported by Soares M in a published review about the under-estimation of outcome in cancer patients using the critical care scoring systems alone and highlighted the importance of specific clinical prognostic factors such as mechanical ventilator and bilirubin for more accurate predication in cancer cases (22) with prolonged stay in ICU. APACHE II was found to be related to prolonged ICU stay, the score was not a significant predictor for prolonged ICU stay in the multivariate analysis. Prolonged stay in ICU was found to be significantly related to higher ICU mortality, however, it was not a significant predictor for ICU mortality. The influence of the prolonged stay in ICU that have on short- and long-term outcomes remains controversial. Several studies (25) have reported higher ICU mortality in patients with a prolonged stay in ICU while others have not (26, 27).

This study targeted patients with solid tumors and identified several predictors of mortality and prolonged stay in ICU. Knowledge on such predictors could offer valuable information for clinicians to avoid futile care and better management of critical care resources. ICU survival rate can be significantly increased in patients with solid tumors with careful patient selection during ICU admission (7). Patients who are at their initial phase of their malignant disease should routinely be admitted to the ICU, some selection criteria including the characteristics of the underlying malignancy are not currently reliable to make appropriate triage decisions (1, 3–7, 17–19). We found that the SOFA score a main determinant and useful in predicting ICU mortality. Understanding the factors affecting the prolonged ICU stay may help in improving the quality of care in ICU such as the infection prevention and mechanical ventilator management. Prolonged stay in ICU will definitely impact the critical care bed availability to avoid delayed ICU admission which been well documented as a significant factor that related to worse patient outcomes. Factors such as organs' failure can be managed easier through earlier admission and evaluation by the ICU team and this might lead to shorter stay in the ICU. This is a prospective registry study with a relatively large number of patients. However, there are a few limitations including being a single-center research. A large multi-center study involving number of ICUs with larger sample size may bear out the findings. Finally, this study collected data only on short term outcomes. Collecting data on long-term outcomes after discharge from ICU could have increased the impact of the current research.

Conclusion:

In conclusion, we found that a reasonable number of patients with solid tumors benefit from ICU admission. In this study, prospective data collection on ICU patients' including characteristics, procedures, treatments and outcomes helped identify predictors of ICU mortality and prolonged stay in ICU. This may have profound implications for assessing the potential benefit of ICU admission, improving the quality of care and efficiency of ICU resources utilization.

Abbreviations

APACHE II
Acute physiology and Chronic Health Evaluation
AST
Aspartate Amino-Transferase
DNR
Do Not Resuscitate
ICU
Intensive Care Unit
MV
Mechanical Ventilator
SOFA
Sequential Organ Failure Assessment
SPSS
Statistical Package for the Social Sciences

Declarations

Ethical approval and consent for to participation:

The IRB of King Abdullah Medical City (KAMC) was obtained

Consent for publication

A consent from the IRB of King Abdullah Medical city was obtained

Availability of Data and Materials:

Data analysis and materials are available upon sending a request to the corresponding author.

Competing Interest:

The authors declare no conflict of interest.

Funding:

None.

Authors' contributions

Acknowledgment:

The authors would like to send their gratitude to King Abdullah Medical City for providing us with the necessary tools and access to make this research happen.

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Figures

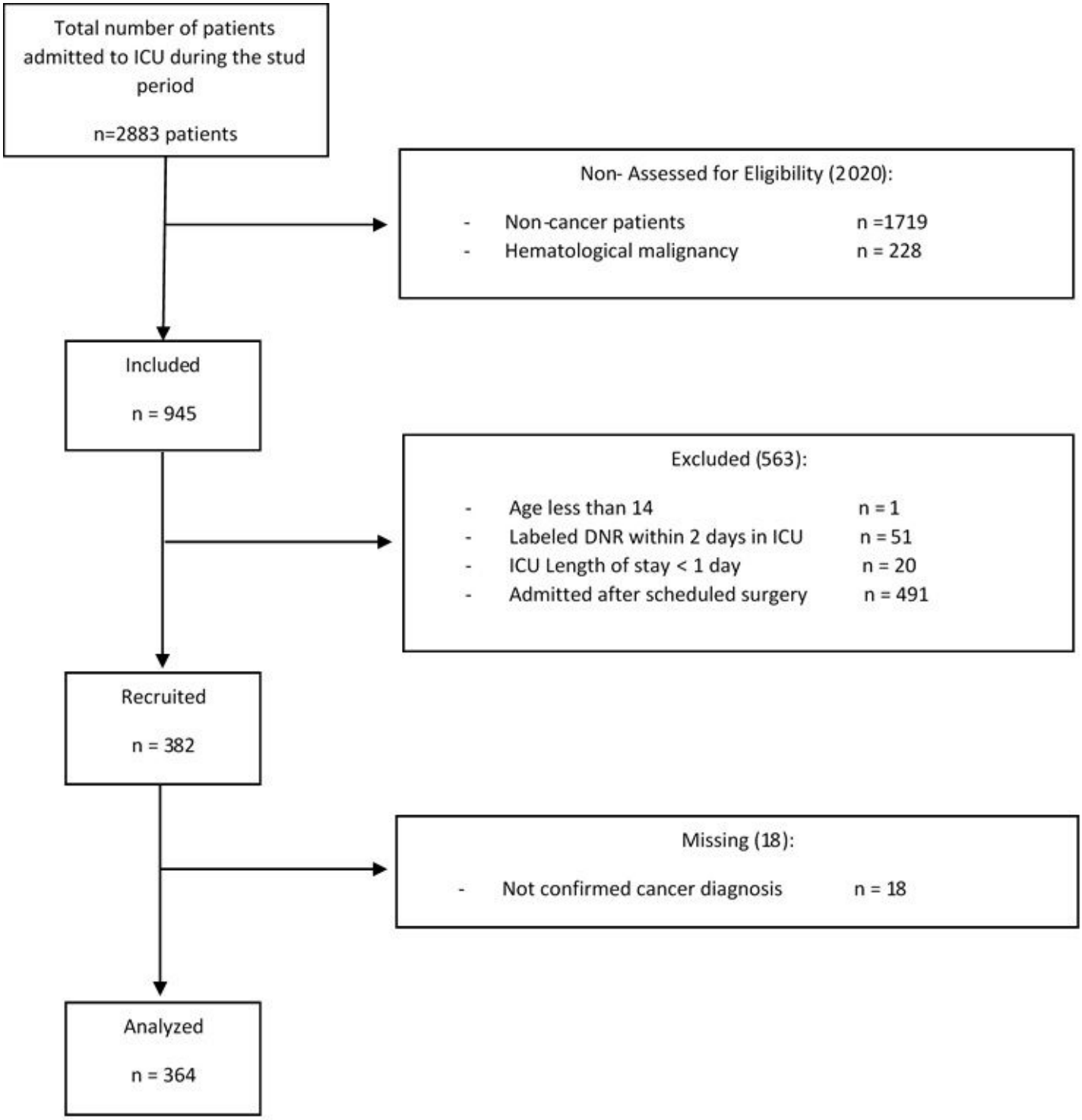

Figure 1

Flow of Population selection process