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ORIGINAL ARTICLE

Prediction of short- and long-term survival for advanced cancer patients after ICU admission

Su Jin Heo · Gyuri Kim · Choong-kun Lee · Kyung Soo Chung · Hye Jin Choi · Joohyuk Sohn · Soohyeon Lee

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Abstract
Background Intensive care unit (ICU) admission of advanced cancer patients is controversial because it is associated with poor short-term prognosis. However, ICU admission of these patients might also result in administration of specific anticancer treatments and evaluation of tumor characteristics, which could influence long-term outcomes. Herein, we investigate whether there is a relationship between ICU admission and long-term outcomes for advanced cancer patients.
Methods We analyzed 116 advanced cancer patients who were admitted to the ICU at Severance Hospital, Yonsei University, between January 2010 and December 2012. We excluded palliative care-only patients. We analyzed demographic, clinical, and survival data of patients admitted to the ICU, and we identified patient characteristics that were measured upon presentation to ICU to determine whether any of these are prognostic or predictive factors of short- or long-term survival.
Results The median age of our study sample was 64 years. Sixty-nine (59.5 %) patients were male. Lung, breast, and stomach were the most common primary tumor sites. Eighty-seven (75 %) patients had received active anticancer treatment within the past 30 days. The main cause of ICU admission was acute respiratory failure (73 %); thus, 102 (87.9 %) patients were managed with conventional mechanical ventilation, 99 (85.3 %) patients in vasopressor and 31 (26.7 %) patients received continuous renal replacement therapy (CRRT). Twenty-four (20.7 %) patients were in postresuscitation status before ICU admission. The ICU, hospital, and 6-month survival rates were 51.7, 31.0, and 15.5 %, respectively. APACHE II score (HR 2.86, 95 % CI 1.00–8.15, $P<0.050$) and need for CRRT (HR 2.14, 95 % CI 1.24–3.70, $P<0.007$) were associated with ICU mortality in a Cox-regression model. Eastern Cooperative Oncology Group (ECOG) performance status (HR 1.64, 95 % CI 1.03–2.62, $P<0.010$) was associated with poor prognosis, and controlled disease status (HR 0.372, 95 % CI 0.21–0.67, $P<0.001$) was found to be a good prognostic factor for 6-month survival after ICU admission.
Conclusions Clinical factors associated with acute, critical status upon ICU admission, such as APACHE II score and need of CRRT, were associated with a higher risk of ICU mortality and short-term mortality than factors directly associated with the patient's cancer. To understand the relationship between ICU admission and long-term survival, however, we have to apply more comprehensive approach that also considers tumor characteristics and disease control status.

Keywords Intensive care unit · Advanced cancer · Short-term survival rate · Long-term survival rate

S. J. Heo · G. Kim · C.-k. Lee · H. J. Choi · J. Sohn · S. Lee (✉)
Division of Medical Oncology, Department of Internal Medicine, Yonsei University College of Medicine, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-752, Republic of Korea
e-mail: socmed0127@gmail.com

K. S. Chung
Division of Pulmonology, Department of Internal Medicine, Yonsei University College of Medicine, Seoul, Republic of Korea

Introduction

The duration of survival for advanced and metastatic cancer patients has substantially prolonged in recent decades due to advances in diagnostics, antineoplastic treatment, and supportive care [1]. In the other side, they may have more chance during their afterlife to receive intensive care in an intensive care unit (ICU), either for cancer-related complications or for treatment-associated side effects [2–5]. Although the survival of critically ill cancer patients is improving, their mortality after ICU admission remains significantly higher than that of

patients who were admitted to the ICUs for non-cancer-related critical disease [6–8]. Previous studies showed that there are wide variations in prognosis depending on the cancer type, stage, reason for admission, and patient comorbidities. Some studies have shown that severity and cause of acute illness, rather than underlying cancer characteristics, are predictive of short-term mortality [5, 7, 9].

The decision regarding whether advanced cancer patients should be admitted to the ICU is based on a complex suite of considerations, including short- and long-term prognosis, quality of life, and therapeutic options to treat cancer; even the wishes of patient and their family must be considered. Metastatic cancer patients usually receive palliative care and have poor long-term survival. Therefore, their admission to ICU raises concerns about patient suffering and meaningless treatment with high financial and resource costs [2, 9].

A better understanding of clinical factors associated with short- and long-term mortality may support more informative discussions between advanced cancer patients and clinicians about patient's prognosis after critical illness [10, 11]. In an observational study of 603 patients with advanced cancer, the discussion of end-of-life issues was associated with lower rates of ICU and mechanical ventilatory support [12]. Furthermore, such discussions tend to reduce unnecessary treatment and wasteful financial and resource use. Therefore, the aims of this study were to describe demographic, clinical, and survival data and to identify factors associated with short- and long-term mortality in critically ill advanced cancer patients who were admitted to the ICU.

Patients and methods

Patients

We designed a retrospective study, analyzing data from the medical records of all patients with advanced cancer admitted to the ICU of a tertiary hospital in Seoul, Korea, between January 2010 and December 2012. This hospital has 180 beds dedicated to cancer care and a closed-unit medical ICU with 18 beds. The policies guiding ICU admission were developed by a multidisciplinary medical staff that included a medical oncologist and a critical care specialist. To be admitted, patients are generally required to have potential for recovery from their acute problems; thus, admission of palliative care-only patients is limited.

During the study period, a total of 140 consecutive patients with prior diagnosis of advanced cancer were admitted to the ICU. Twenty-four patients were excluded (17 were on adjuvant or neoadjuvant chemotherapy not in metastatic disease, two had hematologic malignancies, such as diffuse large B-cell lymphoma, and five were in complete remission; Fig. 1).

Data collection

The following clinical data were collected for 116 enrolled ICU patients: age, gender, type of malignancy, time since diagnosis, number of metastatic sites, number of previous lines of chemotherapy, current cancer status (controlled or not), active treatment in the past 30 days (yes or no), and performance status (PS) within the preceding week according to Eastern Cooperative Oncology Group (ECOG) guidelines [7]. Whether or not the patient received cardiopulmonary resuscitation (CPR) before ICU admission and main reason for ICU admission was recorded. The severity of the acute illness was assessed within 24 h of initial admission to the ICU using Acute Physiology and Chronic Health Evaluation II (APACHE II) system. APACHE II is based on 13 parameters: age, temperature, mean arterial pressure, heart rate, respiratory rate, oxygenation, serum sodium, potassium, creatinine, hemoglobin, white blood cell counts, Glasgow Coma Score, and chronic organ insufficiency/immunocompromised organs [13].

For each patient, we recorded type and number of organ failures during ICU admission as follows: (i) acute respiratory failure defined as respiratory rate >25 breaths/minute, cyanosis, clinical symptoms of respiratory distress, or PaO_2/FiO_2 <300 mmHg; (ii) neurological failure defined as Glasgow Coma Scale score <10, or subjective criteria, such as confusion, decreased responsiveness, or coma in absence of sedation; (iii) renal failure defined as creatinine level >1.4 mg/dL, or creatinine clearance (Cockcroft formula) <60 ml/min; and (iv) infection defined as the presence of pathogenic microorganism in a sterile site (such as blood, abscess fluid, or ascites) and/or clinically suspected infection resulting in septic shock that requires application of vasopressors. Cases of pneumonia and meningitis were categorized as respiratory failure and neurologic failure, respectively.

The main types of management administered in the ICU were conventional mechanical ventilation, vasopressor, and continuous renal replacement therapy (CRRT). The length of ICU or hospital stay was measured as number of days from admission to ICU to discharge from ICU or hospital. We defined hospital mortality to include death during admission and death within 7 days of discharge to include four patients whose deaths were imminent but were discharged beforehand. The type of discharge from ICU (alive, dead, or palliative care only) and patient's vital status 6 months postdischarge from ICU (alive or dead) were also recorded. This study was conducted in accordance with the guidelines of Severance Hospital Institutional Review Board.

Statistical analyses

Continuous variables were reported as means or medians (with 25–75 % interquartile ranges), and categorical variables

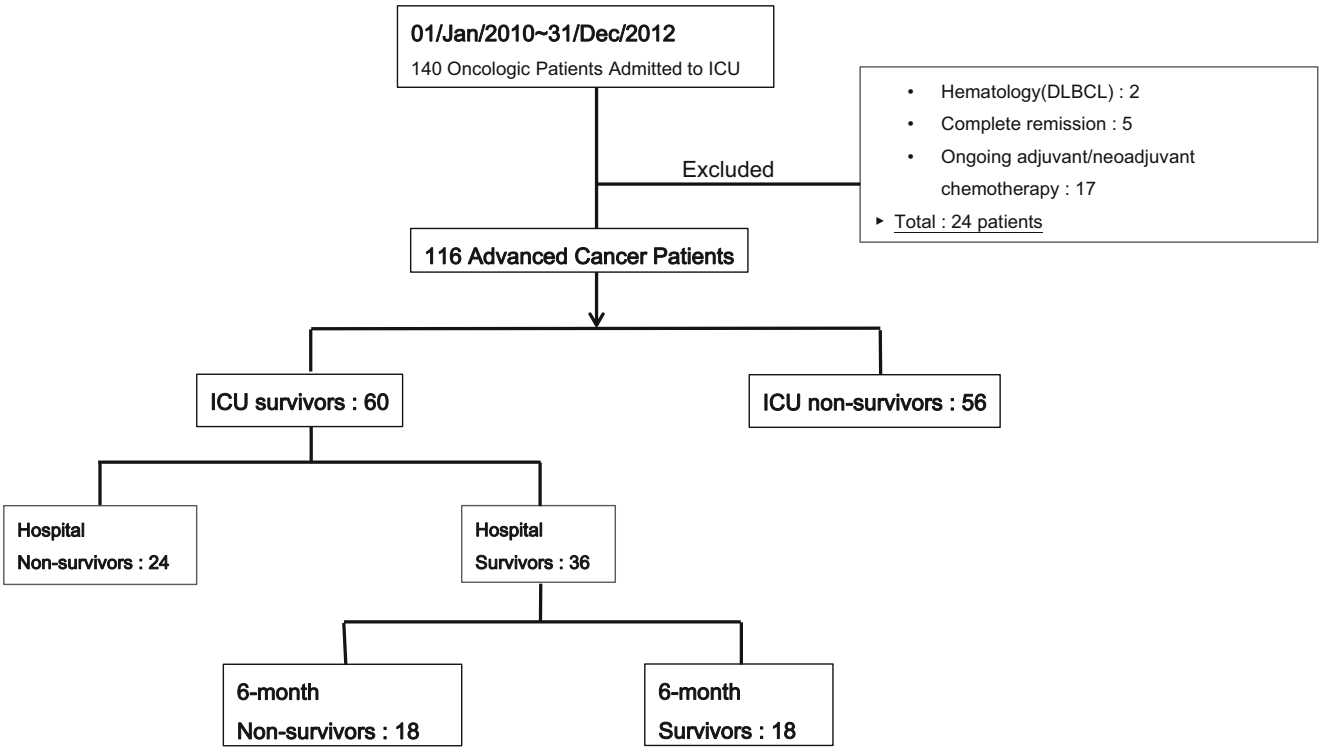

Fig. 1 A total of 140 consecutive patients with prior diagnoses of advanced cancer were admitted to the ICU. Twenty-four patients were excluded because they are not applicable to advanced stage. Sixty patients were ICU survivors and 56 patients were dead in the ICU, namely ICU non-survivors. Of ICU survivors, 36 patients were discharged from hospital, and of them, 18 patients were alive over 6 months, so-called 6-month survivors

were reported as a number (and %), unless otherwise stated. To investigate the association between clinical outcomes of ICU admission, 6-month mortality, and the other covariates, univariate analyses were performed using log-rank test for categorical variables. The significance level was set at a P value of less than 0.05. A Cox proportional hazard model was used for our multivariate approach; for our multivariate model, we only included variables that were associated with a significant P value in univariate analyses. Survival was analyzed by the Kaplan–Meier method, using day of ICU admission until ICU discharge or 6-month all-cause death as the time interval. Patients still alive at the end of this study period were censored at the last follow-up. All statistical analyses were performed using SPSS, version 20.0 (IBM, Armonk, NY, USA).

Results

Baseline characteristics of patients upon ICU admission

The demographic and clinical characteristics of all 116 patients are shown in Table 1. Patient median age was 64.0 years (range, 31 to 86 years), and 69 patients (59.5 %) were male. Malignancy types were as follows: lung cancer (n=37; 31.9 %), breast cancer (n=17; 14,7 %), stomach cancer (n=12; 10.3 %), head and neck cancer (n=11; 9.5 %), colorectal cancer (n=7; 6.0 %), hepatobiliary cancer (n=7; 6.0 %), sarcoma (n=6; 5.2 %), gynecologic malignancy (n=5; 4.3 %), prostate cancer (n=3; 2.6 %), genitourinary malignancy (n=3; 2.6 %), and others (n=8; 6.9 %).

Most of patients (n=87, 75.0 %) underwent active anticancer therapy within 30 days prior to ICU admission, which meant that these 87 patients had longer expected survival than the average life expectancy for people with the same disease status. Fifty-six patients (48.3 %) had no comorbidities and 31 patients (26.7 %) had one comorbidity. There were 68 patients with ECOG performance status (PS) of 0–1 (58.6 %). Eighty-four patients (72.4 %) had two or fewer metastatic sites, and 99 patients (85.3 %) underwent less than second-line chemotherapy. Median time from diagnosis of metastatic cancer to ICU admission was 3.8 months for our patient sample.

Patient disease status classified total patients into two groups followed by their last response evaluation with RECIST version 1.0, controlled or uncontrolled disease groups. The controlled disease status included the following: partial response and stable disease (n=28, 24.1 %). The uncontrolled disease status included newly diagnosed status (n=27, 23.3 %), regimen-changed status within the past 30 days (n=36, 31.0 %), and progressive disease plan to receive a new treatment course (n=25, 21.6 %).

Table 1 Basal characteristics of patients

Clinical variables		Number (116)	Percent
Age (years, median)		64 (31–86)	
Gender	Men	69	59.5
	Women	47	40.5
Type of malignancy	Lung	37	31.9
	Breast	17	14.7
	Stomach	12	10.3
	Head and neck	11	9.5
	Colorectal	7	6.
	Hepatobiliary	7	6.0
	Sarcoma	6	5.2
	Gynecology	5	4.3
	Prostate	3	2.6
	Genitourinary	3	2.6
	Others	8	6.9
Number of metastasis	1	48	41.4
	2	36	31.0
	≥3	32	27.6
Number of comorbidities	0	56	48.3
	1	31	26.7
	≥2	29	25.0
Active treatment in recent 30 days	Yes	87	75.0
	No	29	25.0
Line of chemotherapy	0	18	15.5
	1	58	50.0
	2	23	19.8
	≥3	17	14.7
Known disease status before ICU admission	Controlled		
	Partial response and stable disease	28	24.1
	Uncontrolled		
	Newly diagnosed	27	23.3
	Regimen changed	36	31.0
	Progression disease	25	21.6
ECOG PS	0–1	68	58.6
	≥2	48	41.4

ECOG PS Eastern Cooperative Oncology Group Performance Status

Table 2 Major causes and management outcome of ICU admission

Clinical variables		Number (116)	Percent
APACHE II score (median)		23 (10–48)	
Main causes	Respiratory failure	73	62.9
	Neurology	11	9.5
	Nephrology	10	8.6
	Infection	9	7.8
	Cardiology	7	6.0
	GI Bleeding	6	5.2
CPR before ICU admission	Yes	24	20.7
	No	92	79.3
Managements in ICU	Conventional MV	102	87.9
	Vasopressor	99	85.4
	CRRT	31	26.7
Discharge from ICU	Alive	41	35.3
	Death	56	48.3
	Palliative care only	19	16.4

CPR cardio pulmonary resuscitation, *Conventional MV* conventional mechanical ventilation, *CRRT* continuous renal replacement therapy

Major causes of ICU admission and management strategies

The major causes of and patient management during ICU admission are shown in Table 2. The most common cause of ICU admission was acute respiratory failure (n=73; 62.9 %). Pneumonia was the most common reason for respiratory failure (65.8 %, 48/73), and airway obstruction by tumor mass was the next common (6.8 %, 5/73). Neurologic failure was present in 11 patients (9.5 %), renal failure occurred in 10 patients (8.6 %), infection, excluding pneumonia and meningitis, was present in 9 patients (7.8 %), cardiologic problems occurred in 7 patients (6.0 %), and gastrointestinal tract bleeding occurred in 6 patients (5.2 %). Twenty-four patients presented to the ICU immediately after receiving CPR, and the most common reason for receiving CPR was respiratory arrest (70.8 %, 17/24). During their ICU stay, 102 (87.9 %) patients required endotracheal intubation with conventional mechanical ventilatory support; the median length of mechanical ventilatory support was 4.0 days. Among these, 27 patients underwent tracheostomies due to prolonged time on ventilator care. Ninety-nine (85.3 %) patients required vasopressors for blood pressure support, and 31 (26.7 %) patients required CRRT. Thirty-two (27.6 %) patients were septicemic, as confirmed by blood culture.

Clinical outcomes after ICU admission

The median length of ICU stay was 6 days (range, 1 to 63 days), and hospital stay was 10.5 days (range, 1 to 149 days). ICU discharge types were as follows: 41 patients were alive upon discharge (35.3 %), 56 patients were dead (48.3 %), and 19 patients were discharged alive and were receiving palliative care only (16.4 %). ICU mortality was 48.3 % (56/116), and overall hospital mortality (including death within 7 days of hospital discharge) was 69.0 % (80/116). The 6-month survival rate of ICU survivors was 30.0 % (18/60), and the median survival duration of those 18 patients was 366 days.

We performed univariate and multivariate analyses for ICU mortality (Table 3). Factors associated with significantly higher ICU mortality in univariate analyses were APACHE II score (P=0.013), thrombocytopenia (P=0.024), septicemia (P=0.033), and need for CRRT (P=0.000). ECOG PS was associated with ICU mortality, but not significantly (P=0.160). When these variables were placed in a Cox proportional hazard model, the main prognostic factors of poor ICU survival prognosis were higher APACHE II score (hazard ratio (HR) 2.857; 95 % confidence interval (CI) 1.002–8.149; P=0.050) and need for CRRT (HR 2.139; 95 % CI, 1.237–3.700; P=0.007).

Table 4 summarizes univariate and multivariate analyses for 6-month mortality. Factors associated with significantly higher 6-month mortality not only were the same as for ICU mortality, APACHE II score (P=0.001), septicemia (P=0.031), and need for CRRT (P=0.000) but also included ECOG PS (P=0.006), need for vasopressor therapy (P=0.002), having received CPR (P=0.009), and controlled disease status (P=0.013). Thrombocytopenia (P=0.075) and progression of disease status (P=0.063) were also associated with 6-month mortality, but not significantly. When these variables were placed in a Cox proportional hazard model, the main prognostic factors of poor 6-month survival were APACHE II score (HR 2.083; 95 % CI 1.208–3.592; P=0.008), ECOG PS (HR 1.575; 95 % CI, 1.035–2.395; P=0.034), and controlled disease status (HR 0.438; 95 % CI 0.255–0.754; P=0.003).

Discussion

We assessed the outcomes for advanced cancer patients admitted to the ICU and identified factors influencing short-term and long-term ICU mortality. We defined 6-month survival as long-term survival and ICU survival as short-term survival. Our study showed that clinical factors presenting as acute illness upon ICU admission, such as higher APACHE II score and need for CRRT, were more significantly associated with ICU (short-term) mortality than factors related to malignancy itself. However, for patterns of long-term survival after ICU admission, we have to take comprehensive approach that considers tumor characteristics and disease control status.

Previous studies have sought to identify clinical variables that are associated with poor ICU outcomes, including ICU survival rate. Reichner et al. [14] found that need for mechanical ventilation, advanced lung cancer stage, and higher sequential organ failure assessment score were associated with poor outcome. Boussat et al. [15] concluded that acute pulmonary disease and Karnofsky performance status score of 70 were associated with higher mortality among primary lung cancer patients. Soares et al. [16] found that the best predictors of poor ICU outcome were severity of comorbid illnesses, the number of organ system failures, cancer recurrence or progression, and airway infiltration or obstruction by cancer. In our study, we identified several predictors of poor ICU outcome that included high APACHE II score, thrombocytopenia, septicemia, and need for CRRT. However, in multivariate regression, only APACHE II score and need for CRRT predicted ICU mortality. Regarding the need for CRRT, renal dysfunction is a common complication in patients with cancer and may occur as consequence of cancer itself, cancer treatment, or associated severe complications. Additionally, renal dysfunction can impose limitations on types of chemotherapy that can be administered [17]. For critically ill patients, acute renal dysfunction usually occurs in the context of multiple organ dysfunction and is associated with mortality rates ranging from 53 to 93 % [18–20]. The outcomes of patients who required dialysis after the first day in ICU were considerably worse than those who did not, and no patient who required CRRT beyond their fourth day in the ICU survived [21].

In contrast to short-term outcomes after ICU admission, few studies have evaluated long-term outcomes for patients who are discharged from the ICU alive [22]. We examined patient survival rates 6 months after ICU admission to identify associated prognostic factors. In addition to APACHE II score and need for CRRT, ECOG PS and controlled disease status before ICU admission were found to be significant prognostic factors of 6-month survival not only in univariate analysis but also in multivariate analysis [23]. In many studies, APACHE II score was used with varying success to predict outcomes in cancer patients [24–26, 7, 27]. Christodoulou et al. [7] and Roques et al. [28] found that an ECOG PS of 3–4 was the only characteristic that associated significantly with patient outcome in multivariate analyses. The ECOG PS, which is a simple, but highly effective clinical tool, serves as a proxy for patients' overall health status. It is used to determine whether patient can receive chemotherapy, whether dose adjustment is necessary, and whether patient is eligible to be enrolled in a clinical trial.

In our study, ICU mortality was not correlated with primary tumor site, location of metastatic sites (data not shown), number of metastatic sites, number of comorbidities, or previous chemotherapy treatment lines. In other words, non-cancer related, acute, critical illness was more important in predicting patient mortality than characteristics related directly to patient cancer. This finding is consistent with those from other oncological population studies [7, 29, 30].

CPR is perhaps the most intensive form of care delivered in hospital or ICU setting. Unfortunately, the chance of survival after cardiopulmonary arrest in patients with advanced cancer is rare, with only approximately 5 % of CPR patients alive at the time of hospital discharge [31–33]. In our study, 24 patients underwent CPR and none were alive after 6 months. There can be extensive damage from intensive end-of-life

Table 3 Univariate and multivariate analysis of variables associated with ICU mortality

	Variables	Patients (*N*=116)	ICU survivor (*N*=60 (%))	ICU non survivor (*N*=56 (%))	Univariate analysis		Multivariate analysis	
					HR (95 % CI)	*P* value	HR (95 % CI)	*P* value
Age (median 64 years)	< 64	57 (49.1)	32 (53.3)	25 (44.6)	0.901 (0.28–1.539)	0.704		
	≥64	59 (50.9)	28 (46.7)	31 (55.4)				
Number of comorbidities	0, 1	29 (25.0)	12 (20.0)	17 (30.4)	1.324 (0.745–2.355)	0.339		
	≥2	87 (75.0)	48 (80.0)	39 (69.6)				
Number of metastasis	1	84 (72.4)	39 (65.)	45 (80.4)	0.649 (0.334–1.260)	0.202		
	≥2	32 (27.6)	21 (35.0)	11 (19.6)				
Line of chemotherapy	0, 1	76 (65.5)	43 (71.7)	33 (58.9)	1.568 (0.908–2.710)	0.107	1.525 (0.865–2.689)	0.145
	≥2	40 (34.5)	17 (28.3)	23 (41.1)				
Active treatment in recent 30 days	Yes	87 (75.0)	46 (76.7)	41 (73.2)	0.922 (0.502–1.694)	0.794		
	No	29 (25.0)	14 (23.3)	15 (26.8)				
ECOG PS	0,1	68 (58.6)	39 (65.0)	29 (51.8)	1.462 (0.861–2.482)	0.160	1.3(0.774–2.326)	0.294
	≥2	48 (41.4)	21 (35.0)	27 (48.2)				
APACHE II score	< 18	28 (24.1)	24 (40.0)	4 (7.1)	3.631 (1.311–10.058)	0.013	2.687 (0.935–7.724)	0.047
	≥18	88 (75.9)	36 (60.0)	52 (92.9)				
Hypoalbuminemia (g/dL)	< 2.5	44 (37.9)	20 (33.3)	24 (42.9)	0.873 (0.510–1.493)	0.620		
	≥2.5	72 (62.1)	40 (66.7)	32 (57.1)				
Thrombocytopenia (/μL)	< 100,000	42 (36.2)	15 (25.0)	27 (48.2)	0.542 (0.319–0.922)	0.024	0.717 (0.406–1.269)	0.254
	≥100,000	74 (63.8)	45 (75.0)	29 (51.8)				
Septicemia	Yes	32 (27.6)	8 (13.3)	24 (42.9)	1.800 (1.050–3.086)	0.033	1.522 (0.856–2.707)	0.153
	No	84 (72.4)	52 (86.7)	32 (57.1)				
Planned mechanical	Yes	62 (60.8)	25 (52.1)	37 (68.5)	0.758 (0.421–1.365)	0.356		
Ventilation	No	40 (39.2)	23 (47.9)	17 (31.5)				
CRRT	Yes	31 (26.7)	5 (8.3)	26 (46.4)	2.702 (1.589–4.595)	0.000	2.276 (1.302–3.978)	0.004
	No	85 (73.3)	55 (91.7)	30 (53.6)				
Vasopressors	Yes	99 (85.3)	44 (73.3)	55 (98.2)	3.391 (0.457–25.177)	0.233		
	No	17 (14.7)	16 (26.7)	1 (1.8)				
CPR before ICU admission	Yes	24 (20.7)	11 (18.3)	13 (23.2)	1.179 (0.632–2.200)	0.605		
	No	92 (79.3)	49 (81.7)	43 (76.8)				
Controlled status (PR and SD)	Yes	28 (24.1)	13 (21.7)	15 (26.8)	0.633 (0.341–1.176)	0.148	0.583 (0.302–1.128)	0.109
	No	88 (75.9)	47 (78.3)	41 (73.2)				
Newly diagnosed status	Yes	27 (23.3)	14 (23.3)	13 (23.2)	1.104 (0.588–2.071)	0.759		
	No	89 (76.7)	46 (76.7)	43 (76.8)				
Regimen changed in recent 30 days	Yes	36 (31.0)	18 (30.0)	18 (32.1)	1.436 (0.806–2.558)	0.219		
	No	80 (69.0)	42 (70.0)	38 (67.9)				
Progression disease	Yes	25 (21.6)	15 (25.0)	10 (17.9)	1.020 (0.512–2.032)	0.954		
	No	91 (78.4)	45 (75.0)	46 (82.1)				

ECOG PS Eastern Cooperative Oncology Group Performance Status, *CPR* cardio pulmonary resuscitation, *CRRT* continuous renal replacement therapy

Table 4 Univariate and multivariate analysis of variables associated with 6-month mortality

	Variables	Patients (*N*=116)	6-month survivor (*N*=18 (%))	6-month non survivor (*N*=98 (%))	Univariate analysis		Multivariate analysis	
					HR (95 % CI)	*P* value	HR (95 % CI)	*P* value
Age (median 64 years)	<64	57 (49.1)	7 (38.9)	50 (51.0)	0.762 (0.512–1.134)	0.180		
	≥64	59 (50.9)	11 (61.1)	48 (59.0)				
Number of comorbidities	0, 1	29 (25.0)	4 (22.2)	25 (25.5)	1.062 (0.674–1.672)	0.797		
	≥2	87 (75.0)	14 (77.8)	73 (74.5)				
Number of metastasis	1	84 (72.4)	15 (83.3)	69 (70.4)	1.122 (0.726–1.733)	0.604		
	≥2	32 (27.6)	3 (16.7)	29 (29.6)				
Line of chemotherapy	0, 1	76 (65.5)	13 (72.2)	63 (64.3)	1.256 (0.829–1.903)	0.283		
	≥2	40 (34.5)	5 (27.8)	35 (35.7)				
Active treatment in recent 30 days	Yes	87 (75.0)	15 (83.3)	72 (73.5)	0.773 (0.493–1.212)	0.262		
	No	29 (25.0)	3 (16.7)	26 (26.5)				
ECOG PS	0,1	68 (58.6)	14 (77.8)	54 (55.1)	1.752 (1.170–2.624)	0.006	1.575 (1.035–2.395)	0.034
	≥2	48 (41.4)	4 (22.2)	44 (44.9)				
APACHE II score	< 18	28 (24.1)	9 (50.0)	19 (19.4)	2.333 (1.408–3.867)	0.001	2.083 (1.208–3.592)	0.008
	≥18	88 (75.9)	9 (50.0)	79 (80.6)				
Hypoalbuminemia (g/dL)	< 2.5	44 (37.9)	5 (27.8)	39 (39.8)	0.870 (0.580–1.305)	0.500		
	≥2.5	72 (62.1)	13 (72.2)	59 (60.2)				
Thrombocytopenia (/μL)	< 100,000	42 (36.2)	6 (33.3)	36 (36.7)	0.688 (0.456–1.039)	0.075	0.841 (0.520–1.362)	0.482
	≥100,000	74 (63.8)	12 (66.7)	62 (63.3)				
Septicemia	Yes	32 (27.6)	2 (11.1)	30 (30.6)	1.612 (1.043–2.492)	0.031	1.505 (0.904–2.505)	0.116
	No	84 (72.4)	16 (88.9)	68 (69.4)				
Planned mechanical ventilation	Yes	62 (60.8)	10 (83.3)	52 (57.8)	1.251 (0.823–1.902)	0.295		
	No	40 (39.2)	2 (16.7)	38 (42.2)				
CRRT	Yes	31 (26.7)	1 (5.6)	30 (30.6)	2.483 (1.598–3.858)	0.000	1.592 (0.956–2.651)	0.074
	No	85 (73.3)	17 (94.4)	68 (69.4)				
Vasopressors	Yes	99 (85.3)	10 (55.6)	89 (90.8)	2.983 (1.494–5.957)	0.002	1.839 (0.874–3.870)	0.108
	No	17 (14.7)	8 (44.4)	9 (9.2)				
CPR before ICU admission	Yes	24 (20.7)	0 (0.0)	24 (24.5)	1.848 (1.163–2.939)	0.009	1.384 (0.795–2.409)	0.251
	No	92 (79.3)	18 (100.)	74 (75.5)				
Controlled status (PR and SD)	Yes	28 (24.1)	8 (44.4)	20 (20.4)	0.536 (0.327–0.878)	0.013	0.438 (0.255–0.754)	0.003
	No	88 (75.9)	10 (55.6)	78 (79.6)				
Newly diagnosed status	Yes	27 (23.3)	3 (16.7)	24 (24.5)	1.199 (0.756–1.902)	0.440		
	No	89 (76.7)	15 (83.3)	74 (75.5)				
Regimen changed in recent 30 days	Yes	36 (31.0)	6 (33.3)	30 (30.6)	1.073 (0.698–1.649)	0.748		
	No	80 (69.0)	12 (66.7)	68 (69.4)				
Progression disease	Yes	25 (21.6)	1 (5.6)	24 (24.5)	1.555 (0.977–2.476)	0.063	1.260 (1.029–2.380)	0.366
	No	91 (78.4)	17 (94.4)	74 (75.5)				
ICU	Yes	56	0 (0.0)	56 (57.1)	0.126 (0.075–0.210)	0.000	0.095 (0.051–0.179)	0.095
Mortality	No	60	18 (100.0)	42 (42.9)				

ECOG PS Eastern Cooperative Oncology Group Performance Status, *CPR* cardio pulmonary resuscitation, *CRRT* continuous renal replacement therapy

medical interventions. Caregivers of patients who died in the ICU were more likely to suffer from posttraumatic stress disorder than caregivers of patients who died at home under hospice care [34]. This observation attests to the importance of improved communication, in advance, between clinicians and patients about intensive end-of-life (EOL) care and resuscitation [35].

Our study has some limitations. First, this is a retrospective, single institution study that may not represent general population of critically ill cancer patients. We acknowledge that patient care practices, such as EOL decisions, admission/discharge ICU policies, and criteria to approve administration of mechanical ventilator or CRRT, may vary across hospitals. Second, the study of patients' health-related quality of life (QOL) could not be evaluated, because this is a retrospective study. Ideal assessment of patient outcomes would include multidimensional parameters as well as mortality. Third, due to the cultural and social environment in Korea and other East Asian countries, most advanced cancer patients do not make EOL decisions by themselves. Therefore, admission of advanced cancer patients to ICU is usually decided by physicians together with the patient's family. This approach is far from being ideal.

The admission of advanced cancer patients to ICU has always been controversial. When there is uncertainty or disagreement about the criteria for ICU admission, trial-basis ICU management should be offered to ensure that patient has a possibility of recovering from their acute complication. After 3 days of full life-support management (including transfusions, antibiotics, mechanical ventilation, vasopressors, and dialysis), a reduction in the number of organ failures indicates that additional life-sustaining treatment is in order, whereas absence of response or increase in the number of organ failures should promptly discuss of the appropriateness of continuing aggressive treatments [36, 37].

In conclusion, accurate prediction of short- and long-term survival helps physicians to plan terminal care management and helps administrators properly allocate resources and support services. Advances in both oncology and intensive care may have contributed to improved survival rates, along with better selection of patients most likely to benefit from ICU admission. A multidisciplinary assessment of these patients would ideally be done prior to ICU admission.

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