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ORIGINAL REPORT

Prognosis of Critically Ill Patients With Cancer and Acute Renal Dysfunction

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ABSTRACT

Purpose
To evaluate the outcomes of critically ill patients with cancer and acute renal dysfunction.

Patients and Methods
Prospective cohort study conducted at a 10-bed oncologic medical-surgical intensive care unit (ICU) over a 56-month period.

Results
Of 975 patients, 309 (32%) had renal dysfunction and were studied. Their mean age was 60.9 ± 15.9 years; 233 patients (75%) had solid tumors and 76 (25%) had hematologic malignancies. During the ICU stay, 98 patients (32%) received dialysis. Renal dysfunction was multifactorial in 56% of the patients, and the main associated factors were shock/ischemia (72%) and sepsis (63%). Overall hospital and 6-month mortality rates were 64% and 73%, respectively. Among patients who required dialysis, mortality rates were lower in patients who received dialysis on the first day of ICU in comparison with those who required it thereafter. In a multivariable Cox model, age more than 60 years, uncontrolled cancer, impaired performance status, and more than two associated organ failures were associated with increased 6-month mortality. Renal function was completely re-established in 82% and partially re-established in 12%, and only 6% of survivors required chronic dialysis.

Conclusion
Acute renal dysfunction is frequent in critically ill patients with cancer. Although mortality rates are high, selected patients can benefit from ICU care and advanced organ support. When evaluating prognosis and the appropriateness of dialysis in these patients, older age, functional capacity, cancer status and the severity of associated organ failures are important variables to take into consideration.

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INTRODUCTION

Acute renal dysfunction is a common complication in patients with cancer and may occur as a consequence of the cancer itself (myeloma kidney, urinary tract obstruction), its treatment (acute tumor lysis syndrome, drug induced nephropathy, major surgical procedures), and associated severe complications (sepsis, hypercalcemia).[1,2] In addition, renal dysfunction is associated with a worse prognosis and can impose limitations to the institution of appropriate anticancer therapies.[1-4]

In critically ill patients with cancer, acute renal dysfunction usually occurs in the context of multiple organ dysfunctions and is associated with mortality rates ranging from 53% to 93%.[5-13] Although advances in oncology and supportive care over the last decade have been associated with improvements in the prognosis of critically ill patients with cancer,[13-16] the development of renal dysfunction still poses a dilemma concerning the indication of renal replacement therapy,[5] its timing, and method of choice.[17,18] The decision-making process related to the care of critically ill patients with cancer and acute renal dysfunction could benefit from a better knowledge of the factors that can potentially influence the patients' outcomes. The aim of the present study was to identify characteristics associated with 6-month survival in a large cohort of critically ill patients with cancer and renal dysfunction at the time of admission to the intensive care unit (ICU).

PATIENTS AND METHODS

Design and Setting

From May 2000 to December 2004, a prospective observational cohort study was performed at the Instituto Nacional de Câncer (INCA), Rio de Janeiro, Brazil. INCA

is a 200-bed public hospital for the referral of patients with cancer. The ICU is a 10-bed medical-surgical unit. Information on the organization of the ICU has been previously provided.[19] To be considered for admission to the ICU, patients must usually have a potential chance of cure or cancer control. Infrequently, patients may be admitted during the assessment of their cancer extent and therapeutic options. This assessment is performed as soon as possible. End-of-life (EOL) decisions (to withstand or withhold life-sustaining therapies) are taken in patients who do not recover from the acute illness despite ICU care, or if specific treatment aiming cancer cure or control cannot be given.

This study was supported by institutional funds and approved by the institutional review board, which waived the need of informed consent. The present study did not interfere with clinical decisions related with patient care.

Selection of Participants, Data Collection, and Definitions

During the study period, every adult patient (age $\geq$ 18 years) with cancer requiring admission to the ICU because of an acute complication and presenting with renal dysfunction within the first 24 hours of ICU stay was evaluated. Patients in complete cancer remission for more than 5 years, with an ICU stay less than 24 hours, with end-stage renal diseases requiring chronic dialysis, and those admitted for routine postoperative care were not considered. In case of multiple admissions, only the first one was considered. In our hospital, patients who undergo bone marrow transplantation (BMT) are cared at a separate unit, even when critically ill, and were not studied.

Patients with acute renal dysfunction and with acute on chronic renal dysfunction were evaluated. The diagnosis of renal dysfunction was made according to the criteria proposed by Bellomo et al,[20] which categorize renal dysfunction into three degrees of severity on the basis of the urine output and increases in serum levels of creatinine (creat) and urea: acute renal injury (ARI), acute renal failure syndrome (ARFS), and severe ARFS (defined as any patient with either ARI or ARFS requiring renal replacement therapy; Table 1). Patients who were first classified as ARI or ARFS but evolved with worsening of renal function during the ICU stay were reclassified according to the worst degree of renal dysfunction. Patients with chronic renal dysfunction had a known history of a glomerular filtration rate less than 60 mL/min/m^2 for at least 3 months.[21] Oliguria was defined as urine output less than 400 mL/d or 100 mL/6 hours. Decisions to start, change the method of, or cease renal replacement therapy were taken together by the nephrologist and attending intensivist. At our ICU, the criteria used to indicate renal replacement therapy are usually those from Ronco and Bellomo.[22] Patients receiving vasoactive drugs (dobutamine, norepinephrine, dopamine) and those with potential for hemodynamic instability were treated with extended daily dialysis or continuous renal replacement therapy, the latter being the method employed in patients receiving large doses of norepinephrine and/or dobutamine or in those patients who did not tolerate extended daily dialysis.

The following variables were collected during the first day of ICU: age, sex, the Acute Physiology on Chronic Health Evaluation (APACHE) II,[23] the Simplified Acute Physiology Score (SAPS) II,[24] the Sequential Organ Failure Assessment (SOFA) score,[25] source of admission, main diagnosis for ICU admission, weight loss more than 10% of usual body weight within the previous 3 months, comorbidities, and factors associated with renal dysfunction. Comorbidities were evaluated using the Adult Comorbidity Evaluation-27 (ACE-27), which grades a wide range of comorbid diseases and conditions according to the severity of organ decompensation and prognostic impact.[26] An overall comorbidity score (none, mild, moderate, or severe) is assigned based on the highest-ranked single ailment. The type of cancer, cancer status, anticancer treatments and performance status at the week before hospital admission were also assessed. Performance status was evaluated using the Eastern Cooperative Oncology Group scale.[27] Patients with hematologic malignancies were classified as low-grade or high-grade.[11] Neutropenia was defined as a neutrophil count below 500/mm^3. During the ICU stay, the need for mechanical ventilation for over 24 hours and the development of associated acute organ failures were also assessed. Individual organ failures were defined as a SOFA score of 3 or more points for each system.[25,28] Sepsis was diagnosed according to the criteria of the American College of Chest Physicians/Society of Critical Care Medicine consensus conferences.[29] The 6-month mortality was the end point of interest.

Data Presentation and Statistical Analysis

Standard descriptive statistics were used to describe the study population. Continuous variables are presented as mean $\pm$ standard deviation (SD) or median (25% to 75% interquartile range). For variables that had more than two categories or levels, dummy variables were created; the category with the lowest mortality risk was assigned the reference value of 1. Cox proportional hazard models were used to study the factors associated with 6-month survival. Variables selected in univariate analyses ($P < .25$) and those considered clinically relevant were entered into multivariable Cox proportional hazards regression models to estimate the independent effect of each variable on the survival. Results were reported as hazard ratios (HRs) and respective 95% CIs. Possible interactions were tested. SAPS II and APACHE II scores were not initially entered in multivariate analyses because other independent variables are encompassed by these scoring systems, such as age, variables used to define organ failures, comorbidities and underlying malignancy.[23,24] The assumption of proportionality was verified using Schoenfeld's residual analysis.[30] Martingale residuals were used to assess the functional form of continuous variables.[30] The analysis of the functional form of age in relation to the outcome showed an upward bend around the age of 60 years. Therefore, age was stratified into 60 or fewer and more than 60 years. A two-tailed *P* value less than .05 was considered statistically significant. All models were fitted using the statistical package R.[31]

RESULTS

Characteristics of the Study Population

From 975 patients admitted to ICU with severe acute complications, 309 (32%) fulfilled the eligibility criteria and constituted the study population. The most frequent type of malignancies were non-Hodgkin's lymphoma (n = 45, 15%), upper GI (n = 44, 14%), lower GI (n = 43, 14%), urogenital (n = 39, 13%), head and neck (n = 36, 12%), lung (n = 24, 8%), leukemias (n = 14, 5%), breast (n = 13, 4%), brain (n = 12, 4%), and others (n = 39, 13%). The main patients' characteristics are depicted in Table 2.

Table 1. Criteria for the Classification of Acute Renal Dysfunction

ARI	ARFS	Severe ARFS
Creat > 1.44 mg/dL and urea > 48 mg/dL and/or UO <800 mL/d or UO < 200 mL/6 h	Creat > 2.88 mg/dL and urea > 96 mg/dL and/or UO <400 mL/d or UO < 100 mL/6 h	Need for renal replacement therapy and either criteria for ARI or ARFS
If acute on chronic renal dysfunction: An increase in creat of 0.72 mg/dL or in urea of 24 mg/dL and/or <800/d or UO < 200 mL/6 h	*If acute on chronic renal dysfunction:* An increase in creat of 1.44 mg/dL or in urea of 48 mg/dL and/or UO 400 mL/d or UO < 100 mL/6 h	*If acute on chronic renal dysfunction:* Need for renal replacement therapy and either criteria for acute on chronic renal dysfunction for ARI or ARFS

Abbreviations: ARI, acute renal injury; ARFS, acute renal failure syndrome; creat, serum creatinine concentration; urea, serum urea concentration; UO, urine output.

Table 2. Patient Characteristics

Variables	All patients (N = 309) No.	%	ARI (n = 125) No.	%	ARFS (n = 86) No.	%	Severe ARFS (n = 98) No.	%	*P*
Factors at ICU admission									
Age, years									.001*†
Mean	60.9		64.4		61.2		56.3		
SD	15.9		15.6		15.7		15.4		
Hospital days prior to ICU admission									.738
Median	3		3		3		3		
IQR	1-7		1-6		1-7		1-7		
Male sex	189	61	74	59	53	62	62	63	.822
APACHE II on ICU admission, points									< .001‡§
Median	22.3		20.2		24.1		23.3		
IQR	7.0		6.3		7.3		7.1		
SAPS II on ICU admission, points									< .001*‡
Median	56.9		49.8		63.1		60.7		
IQR	18.2		15.1		18.4		18.8		
SOFA on ICU admission, points									< .001*‡¶
Median	9.6		7.4		10.0		12.2		
IQR	4.1		3.4		3.5		3.8		
Type of cancer									
Locoregional solid tumor	176	57	81	65	45	52	50	51	.006†§
Metastatic solid tumor	57	18	23	18	22	26	12	12	
Low-grade hematologic malignancy	25	8	10	8	5	6	10	10	
High-grade hematologic malignancy	51	17	11	9	14	16	26	27	
Cancer status									
Controlled	158	51	76	61	36	42	46	47	.005‖
Uncontrolled newly diagnosed	85	28	28	22	22	26	35	36	
Uncontrolled recurrence/progression	22	21	21	17	28	33	17	17	
Performance status									
0-1	160	52	71	57	38	44	51	52	.260
2-4	149	48	54	43	48	56	47	48	
Weight loss	29	9	13	10	8	9	8	8	.850
Any comorbidity	291	62	83	66	49	57	59	60	.355
Severe comorbidity	27	9	6	5	8	9	13	13	.083**
Factors during ICU stay									
Mechanical ventilation	240	78	83	66	69	80	88	90	< .001*‖
Vasopressors	212	69	66	53	64	74	82	84	< .001*††
Associated organ failures, No.									< .001*††‡‡
Median	2		1		2		3		
IQR	1-3		0-2		1-3		2-4		
Neutropenia	37	12	10	8	9	10	18	18	.053**
Outcome data									
Length of ICU stay, days									< .001§‖‡‡
Median	5		5		4		9		
IQR	3-13		3-13		2-8		4-16		
Length of hospital stay, days									< .001‖‡‡
Median	15		13		11		20		
IQR	8-31		8-33		6-23		9-33		
End-of-life care decision	81	26	22	18	33	38	26	26	.003††
ICU mortality	170	55	46	37	61	71	63	64	< .001*‡
Hospital mortality	198	64	63	50	66	77	69	70	< .001‡§
6-month mortality	225	73	82	66	69	80	74	76	.049‖

NOTE. Reported *P* values refer to comparisons among different degrees of severity of renal dysfunction.
Abbreviations: SD, standard deviation, IQR, interquartile range; ARI, acute renal injury; ARFS, acute renal failure syndrome; ICU, intensive care unit; APACHE, Acute Physiology on Chronic Health Evaluation; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment.
*$P < .001$ for comparisons between patients with ARI and severe ARFS.
†$P < .05$ for comparisons between patients with ARFS and severe ARFS.
‡$P < .001$ for comparisons between patients with ARI and ARFS.
§$P < .01$ for comparisons between patients with ARI and severe ARFS.
¶$P < .001$ for comparisons between patients with ARFS and severe ARFS.
‖$P < .05$ for comparisons between patients with ARI and ARFS.
**$P < .05$ for comparisons between patients with ARI and severe ARFS.
††$P < .01$ for comparisons between patients with ARI and ARFS.
‡‡$P < .01$ for comparisons between patients with ARFS and severe ARFS.

Table 3. Main Associated Factors of Acute Renal Dysfunction (N = 309)

	No.	%
Ischemia/shock	223	72
Sepsis	195	63
Radiocontrast/nephrotoxins	49	16
Urinary tract obstruction (cancer related)	23	7
Unilateral nephrectomy (cancer)	12	4
Acute tumor lysis syndrome	10	3
Multiple myeloma	9	3
Rhabdomyolysis	3	1
Unknown/other	15	5

NOTE. A patient could have more than one associated condition.

Patients were admitted to the ICU at a median of 3 (range, 1 to 7) days after hospital admission. The major reasons for ICU admission, other than acute renal dysfunction, were severe sepsis/septic shock (n = 181, 59%), acute respiratory failure (excluding septic patients; n = 29, 9%), cardiovascular diseases (n = 19, 6%), cardiopulmonary arrest (n = 15, 5%), neurologic diseases (n = 14, 5%), GI bleeding (n = 8, 3%), shock (excluding sepsis; n = 8, 3%), and miscellaneous (n = 35, 11%). During ICU stay, organ dysfunctions were diagnosed as follows: cardiovascular (n = 212, 69%), respiratory (n = 190, 61%), hematologic (n = 94, 31%), hepatic (n = 52, 17%), and neurologic (n = 51, 17%).

Characterization of Acute Renal Dysfunction

On the first day of ICU, 167 patients (54%) had ARI, 73 (24%) had ARFS, and 69 (22%) had severe ARFS. Thirteen patients (4%) had acute on chronic renal dysfunction. The median creat was 2.06 mg/dL (IQR, 1.61 to 2.85 mg/dL) and urea was 85 mg/dL (interquartile range [IQR], 60 to 125 mg/dL). The median urinary output was 850 mL/d (460 to 1,605 mL/d). The main associated factors of renal dysfunction are presented in Table 3; 173 patients (56%) had more than one reason for the development of renal dysfunction.

Renal function worsened in 59 patients (19%) during ICU stay. Of the patients with ARI on the first day of ICU, 30 evolved to ARFS and 12 to severe ARFS. Seventeen patients who were initially classified as ARFS required dialysis on the subsequent days of ICU stay. Therefore, the worst degree of renal function observed during ICU stay was ARI in 125 (40%), ARFS in 86 (28%), and severe ARFS in 98 (32%) patients. There were significant differences in patients' characteristics among the three groups (Table 2). Patients who received dialysis were younger and had more severe organ failures. Overall, patients with renal injury had a lower degree of severity of acute complication.

Renal Replacement Therapy

Renal replacement therapy was used in 98 patients (32%) during the ICU stay (69 patients received it on the first day of ICU, and 29 thereafter). The initial modalities of renal replacement therapy were daily conventional dialysis (9%), extended daily dialysis (65%), and continuous dialysis (26%).

Patients' outcomes according to the initial classification of the severity of renal dysfunction and the need of dialysis are depicted in Figure 1. The nonadjusted hospital mortality rate of patients who were treated with dialysis on the first day of ICU (severe ARFS) was significantly lower than the pooled mortality of patients with ARI or ARFS who received dialysis subsequently (64% [44 of 69] *v* 86% [25 of 29]; $P = .030$). The 6-month mortality was also lower in those patients, although the results did not reach statistical significance (71% [49 of 69] *v* 86% [25 of 29]; $P = .130$). There were no survivors among the patients who received dialysis later than the fourth day.

Outcome Analysis

The overall ICU, hospital and 6-month mortality rates were 55%, 64%, and 73%, respectively. Mortality rates were significantly different among the categories of renal dysfunction, and were lower in patients with ARI (Table 2). EOL decisions were taken in 81 patients (26%) at a median of 4 days (IQR, two to eight) after ICU admission, and all of these patients died in the ICU. From these patients, 47 (58%) had indication for dialysis at the time of EOL decision and therefore

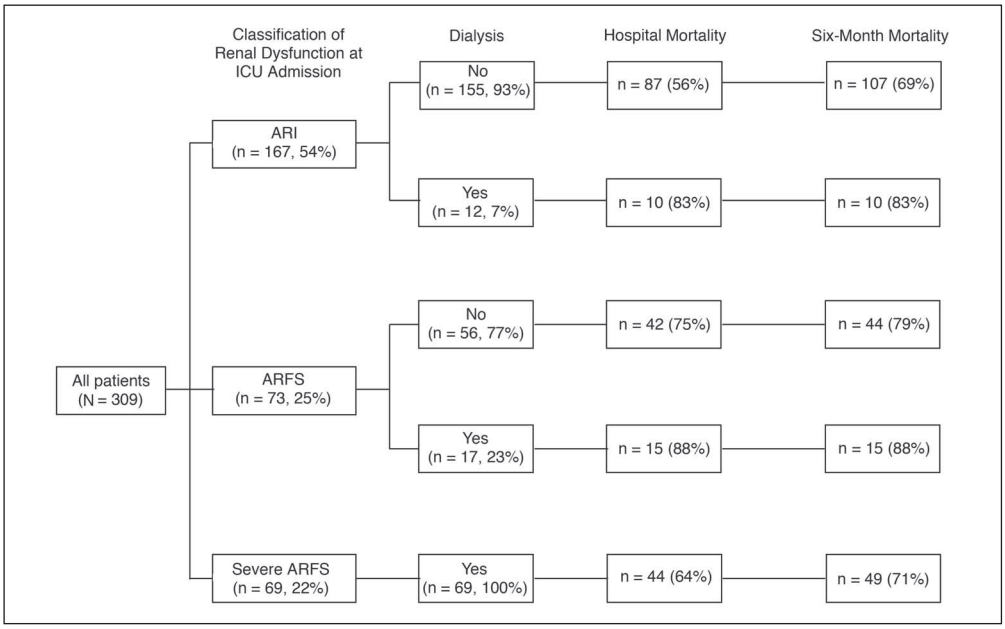

Fig 1. Hospital and 6-month mortality rates according to the initial classification of acute renal dysfunction and temporal indication of dialysis. ICU, intensive care unit; ARI, acute renal injury; ARFS, acute renal failure syndrome.

did not receive it. Median follow-up was 14 days (IQR, 3 to 182). The main patients' outcome data are presented in Table 2.

Age was similar in survivors and nonsurvivors (59.8 ± 13.9 *v* 61.3 ± 16.5 years; $P = .456$). There were no differences in the number of hospital days before ICU admission (3 [IQR, 1 to 7] *v* 2 [IQR, 1 to 6]; $P = .355$). As expected, nonsurvivors had higher APACHE II (23.6 ± 7.0 *v* 18.7 ± 5.9; $P < .001$), SAPS II (62.4 ± 16.5 *v* 42.3 ± 14.2; $P < .001$) and SOFA (10.6 ± 4.0 *v* 7.0 ± 3.2; $P < .001$) points than survivors.

The results of univariable analysis are depicted in Table 4. Age, type of cancer, performance status, cancer status, weight loss, presence

Table 4. Univariable and Multivariable Analyses of Factors Associated With 6-Month Mortality (N = 309)

Variables	6-Month Mortality (%)	Hazard Ratio	95% CI	*P*	Hazard Ratio	95% CI	*P*
Age, years							
<60	70	1.00		.463	1.00		
>60	75	1.11	0.85 to 1.44		1.36	1.00 to 1.84	.049
Sex							
Female	73	1.00		.643	—		
Male	73	0.94	0.72 to 1.23		—		
Type of cancer							
Locoregional solid tumor	66	1.00		.009	—		
Metastatic solid tumor	75	1.57	1.10 to 2.22		—		
Low-grade hematologic malignancy	84	1.40	0.88 to 2.24		—		
High-grade hematologic malignancy	88	1.65	1.17 to 2.34		—		
Performance status							
0-1	61	1.00		< .001	1.00		
2-4	85	2.05	1.57 to 2.67		1.66	1.22 to 2.26	.001
Cancer status							
Controlled	60	1.00		< .001	1.00		
Uncontrolled newly diagnosed	81	1.81	1.33 to 2.47		1.45	1.00 to 2.11	.049
Uncontrolled recurrence/progression	92	2.43	1.76 to 3.37		1.61	1.10 to 2.11	.015
Neutropenia							
No	71	1.00		< .001	—		
Yes	89	1.96	1.35 to 2.84		—		
Weight loss							
No	71	1.00		.001	—		
Yes	93	2.05	1.37 to 3.07		—		
Severe comorbidity (ACE-27)							
No	72	1.00		.234	—		
Yes	81	1.31	0.84 to 2.03		—		
Mechanical ventilation							
No	38	1.00		< .001	—		
Yes	83	3.82	2.53 to 5.76		—		
Number of associated organ failures							
0	33	1.00		< .001	1.00		
1	65	2.74	1.58 to 4.75		1.75	0.88 to 3.50	.110
2	80	4.41	2.66 to 7.32		3.24	1.62 to 6.51	< .001
≥ 3	93	6.07	3.74 to 9.87		4.07	1.94 to 8.54	< .001
Sepsis							
No	53	1.00		< .001	—		
Yes	85	2.26	1.68 to 3.04		—		
Acute on chronic renal dysfunction							
No	74	1.00		.062	—		
Yes	54	0.49	0.23 to 1.04		—		
Worsening of renal function during ICU stay							
No	70	1.00		.042	—		
Yes	85	1.39	1.01 to 1.91		—		
Oliguria							
No	72	1.00		.247	—		
Yes	74	1.17	0.90 to 1.53		—		
Classification of acute renal dysfunction							
Acute renal injury	66	1.00		.004	1.00		
Acute renal failure syndrome	80	1.73	1.25 to 2.38		1.77	1.26 to 2.49	.001
Severe acute renal failure syndrome	76	1.30	0.95 to 1.78		1.16	0.81 to 1.67	.420

Abbreviations: ACE, Adult Comorbidity Evaluation; ICU, intensive care unit.

of neutropenia, severe comorbidity score, need of mechanical ventilation, number of associated organ failures during ICU stay, sepsis, chronic renal dysfunction, deterioration renal function during ICU stay, oliguria, and the severity of renal dysfunction were entered in the multivariable analysis. Age older than 60 years, performance status 2 to 4, more than one associated organ dysfunctions, and ARFS were independently associated with increased 6-month mortality (Table 4). Because most of patients who received EOL decision had indication for dialysis and did not received it, we forced "EOL decision" into the final model and ARFS category was not selected anymore. We also tentatively forced the SAPS II and APACHE II scores into the model. As expected, age older than 60 years lost its predictive value because age is a strong component of both scores. In general, the effect of the other covariates on survival remained unchanged.

Renal function at 6 months of follow-up for all patients and according to the worst classification of renal dysfunction is shown in Figure 2. Of the patients who progressed to end-stage renal disease requiring chronic dialysis (n = 7), four had previous chronic renal dysfunction.

Finally, patients were stratified according to the number of independent risk factors (age > 60 years, ≥2 associated organ failures, performance status 2 to 4, and presence of uncontrolled cancer), and Kaplan-Meier curves were plotted (Fig 3). The 6-month mortality rates were 38% (32 of 85), 84% (163 of 194), and 100% (30 of 30) in patients with 0 to 1, 2 to 3, and 4 risk factors, respectively. All patients with four risk factors died in the hospital and out of them, 16 (53%) received EOL decisions.

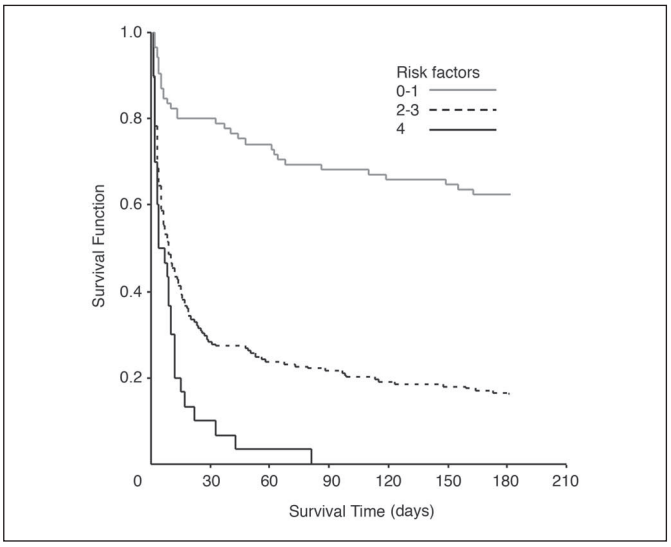

Fig 3. Survival curves for patients with renal dysfunction stratified according to the number of independent risk factors (log-rank test = 79.99; $P < .001$).

DISCUSSION

Cancer patients are at an increased risk for renal dysfunction.[32,33] In the setting of a severe complication, renal dysfunction is an additional source of uncertainty among oncologists, intensivists, and nephrologists in discussions regarding the appropriateness of ICU admission and of initiating renal replacement therapy, because it is usually associated with a poor prognosis.[8,10,12,13] Renal dysfunction can also impose limitations for the administration of chemotherapy.[1] Moreover, information on the prognosis of these patients is scarce. Previous reports have focused on patients requiring dialysis, and most of them were restricted to patients with hematologic malignancies.[3,4,8-10] To the best of our knowledge, the present study is the largest prospective cohort of patients with cancer and renal dysfunction published to date. Patients treated with or without renal replacement therapy were included, and renal dysfunction was re-evaluated during the ICU admission. Although the mortality rate observed was higher in comparison to noncancer patients,[8,34,35] hospital and 6-month survival rates were quite acceptable, and in most patients renal function returned to levels present before the episode of acute renal dysfunction. The frequency of surviving patients who required chronic dialysis is similar to that reported in noncancer patients.[33,35]

Another interesting finding of the present study is related to the timing of dialysis. Hospital and 6-month mortality rates of the patients with severe acute renal failure syndrome, who received dialysis on the

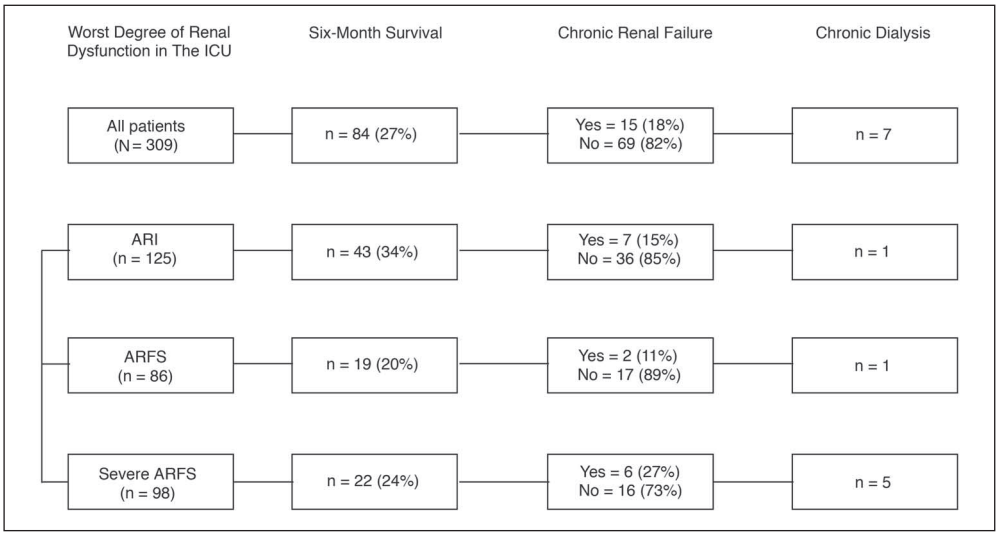

Fig 2. Renal function at 6-months according to the worst classification of acute renal dysfunction during intensive care unit (ICU) stay. ARI, acute renal injury; ARFS, acute renal failure syndrome.

first day of ICU, were similar to those of the patients with ARI, who did not undergo dialysis. In contrast, the outcomes of patients who required dialysis after the first day of ICU were considerably worse and no patient who required it beyond the fourth day survived. Our study was not designed to evaluate the effects of the strategy of renal replacement therapy, since the modality, dose, and quality of dialysis were not assessed. However, our results suggest that, when indicated, dialysis should not be delayed. Moreover, the appropriateness of the institution of dialysis in patients who did not respond to 3 or 4 days of full ICU care must be discussed carefully. Our findings are in agreement with previous reports on the potential benefits of early institution of organ support.[36,37] In a recent study of patients with cancer and respiratory failure, all patients who required mechanical ventilation after the third day of ICU died.[38] Nevertheless, some prudence is needed in the interpretation of these data, because there are significant differences in the criteria used to initiate dialysis among institutions.[39,40] In addition, possible selection biases regarding the indication of dialysis in the present study cannot be ruled out (Table 2).

In this study, the main outcome predictors were older age, impaired performance status, the number of associated organ dysfunctions and the presence of uncontrolled cancer. Although these prognostic factors have been described in critically ill patients with cancer regardless of renal function,[14,11,12,41,42] our results reinforce recent evidence that usual outcome predictors, such as the diagnosis of hematologic malignancies and neutropenia, might have lost their impact on mortality.[8,11,14,16] In accordance with Benoit et al,[8] the present data indicate that the underlying cancer status (in this case, an uncontrolled disease), and not the type of malignancy, must be considered in the decision-making process to admit the patient to the ICU or to start renal replacement therapy. On the other hand, we agree with Azoulay et al,[38,43] who suggest that, when there is uncertainty regarding a patient's outcome, a trial of 3 to 4 days of full intensive care should be offered. The appropriateness of continuing this treatment will be determined by the subsequent patient's clinical response. In a recent study of patients with severe sepsis, mortality was closely associated with early changes in the severity of organ dysfunctions. Even improvements in organ functions on subsequent days had only a modest impact on the probability of survival.[44]

This study has other potential limitations. Because it was conducted in a single center, possible selection biases concerning differences in patterns of care (EOL decisions, admission/discharge ICU policies, and criteria to indicate renal replacement therapy) cannot be ruled out. In addition, BMT patients were not evaluated. These aspects should be considered in the generalization of our results. Furthermore, the patients' health-related quality of life was not evaluated. The ideal assessment of the patients' outcome must include multidimensional parameters other than mortality. Recently, it has been reported that health-related quality of life in patients with acute renal dysfunction is lower than that of the general population.[45]

In conclusion, acute renal dysfunction is frequent in critically ill patients with cancer. The current study suggests that dialysis should not be denied for these patients. Older age, impaired performance status, presence of an uncontrolled cancer (not the type of cancer), and especially more than two other organ dysfunctions are the main factors associated with an adverse outcome in these patients. The simultaneous presence of all these factors is almost invariably indicative of an adverse outcome. However, selected patients can benefit from ICU care and advanced organ support.

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