Impact of critical care response team implementation on oncology patient outcomes: A retrospective cohort study

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ABSTRACT

Introduction: The main goal of a critical care response team (CCRT) is to quickly assess and transfer, if required, rapidly deteriorating patients to an intensive care unit (ICU) to prevent cardiopulmonary arrest, stabilize patients’ condition, and help in optimizing the care provided by the primary team. The objective of this study was to investigate the correlation between early intervention by CCRT and the outcome of oncology patients.

Materials and Methods: This is a retrospective cohort study conducted at King Abdulaziz Medical City (KAMC), Riyadh, Saudi Arabia. KAMC is a tertiary care facility with 1200-bed capacity. The study compared oncology patients to nononcology patients.

Results: Over 4 years, a total number of 4941 patients were reviewed, of which 172 were oncology patients. The average age of patients in the oncology group was 48.8 ± 20.7, while the average age for nononcology was 52.8 ± 21.2 (P = 0.016). The average Acute Physiology and Chronic Health Evaluation II score on admission for oncology patients was higher than that for the nononcology group (27.8 ± 8.9 vs. 23.6 ± 9.3, respectively). Lower ICU mortality was seen after CCRT implementation (38.8% vs. 62.7%). The average duration of hospital stay and ICU stay increased after CCRT implementation (37.34 vs. 29.31 and 11.93 vs. 8.9, respectively).

Conclusion: In this study, we identified that early intervention by implementing CCRT had a significant impact in reducing ICU mortality for oncology and nononcology patients.

Key Words: Cancer, critical care response team, oncology

INTRODUCTION

Due to the expanding role of intensive care unit (ICU) over the past 20 years, the care of critically ill patients in ICUs has become the responsibility of specialized critical care personnel.[1] A rapid response system (RRS) was established to ensure timely interventions for hospitalized patients and to detect acutely deteriorating patients; this system aims to prevent patient deterioration and unexpected deaths due to clinical errors.[2‑4] RRS can be referred to as a critical care team, medical emergency team, or a rapid response team.[3] Several studies have demonstrated the necessity of an RRS system for reducing the morbidity and mortality of patients.[5‑9]

The effects and benefits of a critical care response team (CCRT) on patient care can be observed in the resuscitation and identification of rapidly deteriorating patients.[10] Addressing the do-not-resuscitate (DNR) status for patients in the ward is a new role of the CCRT and has been explored during the process of
implementation of teams.\textsuperscript{[11]} Identifying DNR cases early results in the prevention of unnecessary admissions to ICUs.\textsuperscript{[10]}

Advances in early diagnosis and aggressive management of cancer have improved long-term outcomes.\textsuperscript{[18]} However, some cancer patients develop several complications and/or treatment-associated side effects\textsuperscript{[13]} which often require multidisciplinary care in an ICU\textsuperscript{[14,15]} Early admission to an ICU has been associated with lower mortality rates when compared to late admissions for the general ICU population.\textsuperscript{[16]} The same was found in critically ill cancer patients, and late ICU admission was associated with increased mortality.\textsuperscript{[17,18]} Improving the outcome in critically ill cancer patients may occur by early intervention, before ICU admission and the development of severe organ failure.\textsuperscript{[19]} However, there is currently a lack of evidence on the outcome of early intervention of a CCRT on cancer patients.

CCRTs at the Ministry of National Guard Health Affairs hospitals were initiated in 2007. The main goal of the CCRT is to quickly assess and transfer, if required, rapidly deteriorating patients to the ICU to prevent cardiopulmonary arrest, stabilize patients’ condition, and help in optimizing the care provided by the primary team. The objective of this study is to determine the correlation between early intervention and late intervention by CCRT and compare the outcome of oncology patients to nononcology patients.

MATERIALS AND METHODS

Setting
This is a retrospective cohort study conducted at King Abdulaziz Medical City (KAMC), a tertiary care teaching hospital in Riyadh, Kingdom of Saudi Arabia. KAMC is a 1200-bed capacity tertiary care facility with 9 different ICUs.

Populations
Patients admitted both before and after early intervention by CCRT were included in the study. The study included all adult patients over the age of 16 years. Eligibility for patient inclusion was based on the CCRT calling criteria which include respiratory rate >30 breath/min or <8 breaths/min or oxygen saturation ≤90%, systolic blood pressure ≤90 or ≥220 mmHg, heart rate ≤40 or ≥130 beats/min, urine output ≤100 mL over 4 h, decreased level of consciousness by ≥2 points on the Glasgow Come Scale (GCS) or repeated seizures, and any serious concern about the patient’s clinical condition. All patients were from general wards (non-ICU patients). All eligible ward patients were followed in the ward or in the ICU, if admitted, until patient discharge from the hospital or death.

Study design
Data were collected over a 5-year timeframe, from 2006 to 2010. The data from January 1, 2006, to November 23, 2007, were the pre-CCRT period, and the data from December 1, 2007, to December 31, 2010, were the post-CCRT period. The study compared the demographics and outcome between oncology and nononcology patients before and after CCRT implementation. All patients received follow-up during their stay in the hospital, and no follow-up occurred after discharge. Patients who were kept in ICU only for observation and monitoring and any incomplete case records were excluded from the study.

Statistical analysis
Statistical analysis was done using IBM\textsuperscript{®} SPSS version 16.0 statistical software package (IBM Corp, Armonk, USA). Variables were presented as frequencies and percentages for qualitative data, while mean and standard deviation were used for quantitative data. The Acute Physiology and Chronic Health Evaluation II (APACHE II) was utilized when classifying the severity of disease. Student’s \( t \)-test was used to compare quantitative variables; Chi-square test was used for comparing qualitative variables between the groups. \( P \leq 0.05 \) was considered statistically significant.

RESULTS

The present study included 4941 patients, of which 172 were oncology and 4769 were nononcology patients. Patient demographics and clinical characteristics are shown in Table 1. For oncology patients, the average age was 48.8 ± 20.7, while the average age for the nononcology patients was 52.8 ± 21.2; there was a significant difference between the two groups. Patients were classified into three age groups: patients younger than 41, patients between 41 and 65 years old, and patients older than 65 years. There was a significant difference between oncology and nononcology patients younger than 41 years of age [Table 1].

As shown in Table 2, the majority of the patients were admitted for cardiovascular diseases, postoperative care, and respiratory diseases. However, there were significant differences between oncology and
nononcology admission categories. The majority of the patients were referred from the floor. A significant difference for referral reasons can be seen between both the groups [Table 2]. The mean APACHE II score on admission for the oncology group was higher (27.8 ± 8.9) than the nononcology group (23.6 ± 9.3). The majority of the oncology patients (41.6%) had a score of 21–30, while the majority of the nononcology patients (40.2%) had a score of ≤20 [P < 0.001, Table 2]. The average score of GCS for oncology patients was higher (10.9 ± 4.8) than the score for nononcology patients (9.4 ± 4.4, P < 0.001). There was a significant difference between both the patient groups in all chronic health points, liver disease, cardiovascular disease, respiratory disease, renal disease, and immune-compromised patients. Diabetes was more prevalent in nononcology patients (36.1%) than oncology patients (22.7%). Table 2 shows that no code oncology patients accounted for 36.6% of the patients, while no code nononcology patients accounted for 18.5% of the patients. There was a significant difference in APACHE II scores between oncology and nononcology patients [P < 0.001, Table 2].

The outcome of oncology and nononcology patients before and after CCRT implementation is shown in Table 3. In oncology patients, there was a significant difference in ICU mortality, duration of hospital stay, and duration of post-ICU stay (P = 0.004, P = 0.034, and P = 0.004, respectively). Less mortality in ICUs was seen after CCRT implementation (38.8%) than before CCRT [62.7%, Table 3]. The average hospital duration and post-ICU duration increased after CCRT compared to before CCRT (37.34% vs. 29.31% and 11.93% vs. 8.9%, respectively). In nononcology patients, there were significant differences in hospital mortality, tracheostomy, and readmission. Hospital mortality, tracheostomy, and readmission rates decreased after the implementation of CCRT [Table 3]. Hospital mortality decreased after CCRT implementation from 38.5% to 33.9%, and less patients required tracheostomy after CCRT compared to before CCRT (15.9% vs. 19.1%, respectively). After CCRT, fewer patients required readmission compared to before CCRT [11.1% vs. 13.6%, respectively; Table 3].

When comparing the two groups of patients: oncology and nononcology groups, significances were found in ICU mortality, hospital mortality, tracheostomy, sepsis, post-ICU duration, pre-ICU duration, and ventilation days. ICU mortality was less in nononcology patients (22%) than oncology patients (38.8%) after CCRT. In addition, hospital mortality was less in nononcology patients (33.9%) than oncology patients (55.4%) after CCRT. More nononcology patients (15.9%) required a tracheostomy than oncology patients (4.1%). Sepsis was increased in oncology patients (71.7%) compared to nononcology patients (27.5%) after CCRT. The average post-ICU duration and ventilation days were less in oncology patients (11.93% and 5.59%, respectively) than

Table 2: Clinical characteristics of patients upon admission to the Ministry of National Guard Health Affairs hospitals in Saudi Arabia (2006-2010)

| Clinical characteristics                  | Oncology (%) | Nononcology (%) | Total (%) | P   |
|------------------------------------------|--------------|-----------------|-----------|-----|
| Referral category                        |              |                 |           |     |
| Respiratory                              | 29 (16.9)    | 931 (19.5)      | 960 (19.4) | <0.001* |
| Cardiovascular                           | 123 (71.5)   | 1473 (30.9)     | 1596 (32.3)|     |
| Neurologic                               | 11 (6.4)     | 325 (6.8)       | 336 (6.8) |     |
| Other medical                            | 3 (1.7)      | 194 (4.1)       | 197 (4.0) |     |
| Nonoperative trauma                      | 0 (0.0)      | 390 (8.2)       | 390 (7.9) |     |
| Postoperative                            | 6 (3.5)      | 1456 (30.5)     | 1462 (29.6)|     |
| Admission service                        |              |                 |           |     |
| Medical                                  | 172 (100.0)  | 2244 (47.1)     | 2416 (48.9)| <0.001* |
| Surgical                                 | 0 (0.0)      | 2301 (48.2)     | 2301 (46.6)|     |
| Obstetrics and gynecology                | 0 (0.0)      | 79 (1.7)        | 79 (1.6)  |     |
| Orthopedics                              | 0 (0.0)      | 145 (3.0)       | 145 (2.9) |     |
| APACHE II score on admission groups      |              |                 |           |     |
| Mean ± SD                                | 27.8 ± 8.9   | 23.6 ± 9.3      | 23.7 ± 9.4 | <0.001* |
| ≤20                                      | 25 (22.1)    | 1170 (40.2)     | 1195 (39.5)| <0.001* |
| 21–30                                    | 47 (41.6)    | 1090 (37.4)     | 1137 (37.6)|     |
| >30                                      | 41 (36.3)    | 652 (22.4)      | 693 (22.9) |     |
| Glasgow Coma Score groups                |              |                 |           |     |
| Mean ± SD                                | 10.9 ± 4.8   | 9.4 ± 4.4       | 9.5 ± 4.5 | <0.001* |
| Chronic health points                    |              |                 |           |     |
| Liver disease                            | 6 (3.6)      | 508 (10.9)      | 514 (10.7) | 0.003* |
| Cardiovascular disease                   | 25 (15.0)    | 1193 (25.6)     | 1218 (25.3)| 0.002* |
| Respiratory disease                      | 17 (10.2)    | 854 (18.4)      | 871 (18.1)| 0.007* |
| Renal disease                            | 14 (8.4)     | 780 (16.8)      | 794 (16.5)| 0.004 |
| Immunocompromised                        | 148 (86.5)   | 398 (8.6)       | 546 (11.3)| <0.001* |
| Diabetes                                 | 39 (22.7)    | 1720 (36.1)     | 1759 (35.6)| <0.001* |
| No code                                  | 21 (12.2)    | 881 (18.5)      | 944 (18.1)| <0.001* |
| Mortality prediction                     |              |                 |           |     |
| APACHE II                                | 0.59 ± 0.26  | 0.44 ± 0.29     | 0.44 ± 0.29| <0.001* |

*Irrespective of CCRT team implementation (i.e., for all patients included both before and after). APACHE II: Acute Physiology and Chronic Health Evaluation II, CCRT: Critical care response team, SD: Standard deviation.
in oncology patients (34.08% and 7.18%, respectively) after CCRT, while the average pre-ICU duration was increased in oncology patients (18.36%) when compared to nononcology patients (12.06%) after CCRT.

### DISCUSSION

This is the first study to investigate the outcome of early intervention of CCRT on oncology patients. CCRT is a team of specially trained clinical personnel capable of providing critical care for patients bedside and preventing the deterioration of patients’ status. Several reports showed that the range of ICU mortality rates of critically ill oncology patients was 15.9%–32%. The ICU mortality rate of oncology patients was reported to be 27% in European ICUs. Several indicators of poor prognosis in cancer were reported including older age, high APACHE II scores, and sepsis.[24]

Patients from the nononcology group were significantly older than those from the oncology group, specifically for those older than 65 years of age. In addition, they had a higher average BMI compared to patients from the oncology group. Males were more prevalent in both the groups. Admission of oncology and nononcology patients was mainly due to cardiovascular reasons, followed by respiratory reasons for oncology patients and postoperative reasons for nononcology patients. The majority of the patients in both the groups were admitted to ICU nonoperatively for medical reasons referred from the floor. It was reported that APACHE II scores were fairly accurate at predicting ICU mortality of critically ill oncology patients with acceptable calibration and good discrimination.[21,25] The average APACHE II score for oncology patients was significantly higher than that of nononcology patients, with a significant dominance of score 21–30 in oncology patients and dominance of score ≤20 in nononcology patients.

In the present study, we investigated the outcome of both the groups before and after CCRT and then compared them with each other. ICU mortality rates significantly decreased in oncology patients after CCRT, while no difference was found in nononcology patients; there was a significant difference between the two groups. Nononcology patients had lower APACHE II score compared to oncology ones.[26]
Hospital mortality decreased after CCRT in both the groups with no significance in the mortality rate in oncology patients and a significant decrease in nononcology patients; there was a significant difference between the two groups. A study from a tertiary care oncology hospital reported that mortality rates decreased after the introduction of CCRT.[27] The present study showed no significant difference in outcome before and after CCRT in each group and between the two groups regarding cardiovascular arrest, ventilator use, and readmission within 48 h.

In a previous study, it was found that cardiac arrest slightly decreased after the introduction of CCRT.[27] The rate of performing tracheostomy was decreased after CCRT in both the groups without significance in oncology patients and with significance in nononcology patients, while there was a significant difference between the two groups. Readmission of patients was significantly decreased after CCRT in nononcology patients, while no significant difference was found in oncology patients.

Oncology patients were found to have an increased risk of sepsis compared to other patients which may be due to the immunosuppression caused by treatment of malignancy or malignancy itself.[17,23,28] Oncology patients have a fourfold increase in severe sepsis in comparison to noncancer patients with 16.4/1000 cancer cases.[29,29] The present study revealed that the sepsis rate after CCRT significantly decreased in nononcology patients while slightly increasing in oncology patients; there was a significant difference between the two groups.

In a previous study,[27] it was found that the introduction of a CCRT in a tertiary-care oncology hospital had no significant effect on the hospital length of stay. However, the current study found that the average hospital duration was significantly increased after CCRT in the oncology group. No difference was found between oncology and nononcology for hospital duration. Increased hospital duration may be contributed to the influence of CCRT on the primary teams’ decision for the required length of care.[30] In addition, the tracheostomy rate after CCRT was significantly increased in nononcology patients (P < 0.001) which required further management by multidisciplinary teams (speech therapist, swallowing assessment, and tracheostomy education). No significant difference was found in ICU duration after CCRT in either group or between both the groups.[31] The average duration of post-ICU significantly decreased after CCRT in oncology patients, while no significant difference was found in nononcology patients. However, there was a significant difference between the two groups. The average ventilation days slightly decreased in oncology patients while remaining constant in nononcology; there was a significant difference between the oncology and nononcology groups.

This study found a positive outcome of CCRT intervention in oncology and nononcology patients. The ICU mortality rate was significantly decreased after CCRT implementation in oncology patients. Further studies are recommended to fully understand the benefits of CCRT intervention in oncology and nononcology patients, as this is the first study to evaluate the outcome of early intervention of oncology patients after CCRT implementation.

**Research quality and ethics statement**

The authors of this manuscript declare that this scientific work complies with reporting quality, formatting, and reproducibility guidelines set forth by the EQUATOR Network. The authors also attest that this clinical investigation was determined to require Institutional Ethics Committee, Research Cell, King George’s Medical University, Lucknow and appropriate approval (84th ECM II-B- Thesis) was granted by the Research Cell, King George’s Medical University, Lucknow.

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**Conflicts of interest**

There are no conflicts of interest.

**Ethical conduct of research**

This study was approved by the Institutional Review Board / Ethics Committee. The authors followed applicable EQUATOR Network (http://www.equator-network.org/) guidelines during the conduct of this research project.

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