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Characteristics and outcomes of cancer patients with covid-19 at a safety-net hospital

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ARTICLE INFO

Keywords:
Cancer
Covid-19 infection
Anti-cancer treatment
SARS-CoV-2

ABSTRACT

Patients with cancer are a vulnerable population during the COVID-19 pandemic due to underlying immunosuppression, pre-existing comorbidities, and poor nutrition. There is a lack of data describing the disease course of cancer patients with COVID-19 disease. Therefore, we analyzed data from cancer patients with COVID-19 who were admitted to our hospital. Cancer patients were categorized into two groups as survivors and non-survivors of COVID-19. Among 68 cancer patients with COVID-19, 27% of patients were admitted to ICU, and 37% of the patients died. The median age was 72, and non-survivors were older than survivors (p = 0.001). Non-survivors had higher comorbidity scores, late-stage cancer, and worse ECOG performance status than survivors (all p values < 0.005). Non-survivors also had significantly lower lymphocyte count and albumin level but higher lactate dehydrogenase, C-reactive protein, fibrinogen, troponin, and ferritin levels than survivors. On multivariable analysis, increased age and mechanical ventilation were associated with increased odds of death. We report no association between anti-cancer treatments and mortality from COVID-19 disease. In summary, cancer patients have higher mortality of COVID-19 infection than the general population. In addition to generally known risk factors, the high mortality rate in cancer patients with COVID-19 is associated with several cancer-specific factors.

Introduction

The novel severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) was first detected in December 2019 in Wuhan, China, then spread rapidly to almost every country globally, with United States, India, and Brasil as impacted the most [1]. The World Health Organization nominated SARS-CoV-2 as the cause of the Coronavirus Disease 2019 (COVID-19) and has been formally declared a pandemic [2]. As of May 28, 2021, more than 170 million cases have been confirmed worldwide, leading to 3.5 million deaths [3].

Patients with cancer are a vulnerable population during the COVID-19 pandemic for many aspects, including underlying immunosuppression, pre-existing comorbidities, and poor nutrition. Especially critically ill cancer patients are more prone to having macro- and micro-nutrition deficits, leading to poorer outcomes [4]. Cancer patients often have high exposure to the healthcare system due to follow-up visits for treatment, surveillance, and supportive care. Liang et al. reported that cancer patients had poorer outcomes and higher incidence of COVID-19 than the general population [5]. They also reported a higher rate of serious adverse events such as intensive care unit admissions and requiring invasive ventilation. Another study found a 28.6% case-fatality rate of COVID-19 in patients with cancer [6]. Cancer patients might be immunocompromised due to antineoplastic therapy, some supportive medications including steroids, and the immunosuppressive nature of cancer itself [7]. Thus, patients with cancer seemed to be at high risk for developing unfavorable outcomes. To date, limited data exist describing the disease course of patients with cancer who infected with COVID-19. Current studies are limited by small sample sizes. The mortality outcomes of COVID-19 and either systemic antineoplastic treatment or immunotherapeutic drugs are mainly unknown, limited with small studies.

The clinical characteristics of cancer patients infected with COVID-
19 largely remain obscure. Given the vulnerability of the cancer patients and potentially severe outcomes of COVID-19, an understanding of the factors related to clinical outcomes in patients with cancer is urgently needed. Therefore, we collected and analyzed data from cancer patients with COVID-19 who were admitted to our hospital. In this retrospective study, we aimed to describe clinical characteristics and outcomes of patients with cancer diagnosed with COVID-19 and identify risk factors associated with in-hospital mortality.

Materials and methods

In this retrospective study, we reported patients with COVID-19 who had a history of cancer. The patient data was collected in Capital Health Regional Medical Center between March 2020 and October 2020. This study was approved by the Institutional Ethics Committee of Capital Health Regional Medical Center. The need for informed consent was waived by the ethics committee due to the retrospective nature of the study and no identifiable patient information published. Two physicians (MO and MM) independently verified the data accuracy.

Patients with laboratory-confirmed SARS-CoV-2 were included. Patients with only clinically and radiologically diagnosis of COVID-19 were excluded from the study.

Cancer patients were categorized into two groups as survivors and non-survivors of COVID-19. We included demographics (age at diagnosis, gender, race/ethnicity, insurance status), clinical findings (obesity status, comorbidity score, smoking status, type of malignancy, stage of disease, performance status, therapies, oxygen requirement, admission to intensive care unit (ICU), and laboratory findings. Obesity status was defined as overweight (BMI 25–29.9) and obese (BMI ≥30). The comorbidity score was calculated using the Charlson Comorbidity Index and categorized as ≤3 and >3. Smoking status was divided into three groups: Never smoker, a former smoker, and a current smoker. Functional status was evaluated using the Eastern Cooperative Oncology Group (ECOG) performance status scale. The staging was described as early-stage (I-II) and late-stage (III-IV) for solid malignancies. We defined active anti-cancer therapy if patients received systemic chemotherapy or others within four weeks of COVID-19 diagnosis. COVID-19 treatment information was also collected: Remdesivir, convalescent plasma, tocilizumab, dexamethasone, methylprednisolone, hydroxychloroquine, azithromycin. Time to ICU admission was defined as the number of days from ward admission to ICU admission.

Statistics

We used the t-test, chi-square, or Fisher’s exact test as appropriate to compare the baseline characteristics between survivor and non-survivor patients with COVID-19. The multivariable logistic regression model was performed to assess the association between variables and death. The odds ratio (OR) and 95% confidence interval (CI) were calculated with the logistic regression model. All analyses were performed using SPSS version 22, and p < 0.05 was considered statistically significant.

Results

We identified 562 patients with COVID-19; 68 (12%) patients had a history of cancer. Among 68 cancer patients with COVID-19, 25 (37%) patients had died of COVID-19. The median age was 72 (23–91), and non-survivors were older than survivors (median age 67 vs. 77, p = 0.001). Thirty-seven (54%) patients were male, and 36 (53%) patients were Black. Non-survivors were more likely to be male (68% vs. 32%) and Black. Twenty-five (37%) patients were overweight, and 19 (28%) patients were obese. Forty-four (65%) patients had never smoked. Thirty-nine (57%) patients had comorbidity scores >3, and non-survivors had higher comorbidity scores compared to survivors (80% vs. 44%, p = 0.004). The most common cancer type was breast cancer (22%), following by prostate cancer (18%), lung cancer (12%), hematological cancers (12%), and colon cancer (10%). The most common insurance type was Medicare MGD insurance (49%) which was higher in non-survivors compared to survivors (64% vs. 40%, p = 0.002). Non-survivors had worse ECOG performance status than survivors (p<0.001). Nineteen (76%) patients had an ECOG performance status of 3, and 6 (24%) patients had an ECOG performance status of 4 among non-survivors. Twenty-two (32%) patients received anti-cancer therapy within four weeks of COVID-19 diagnosis, including systemic chemotherapy (19%), radiotherapy (3%), hormonotherapy (9%), and others (2%). The most common treatment of COVID-19 was methylprednisolone (29%), followed by dexamethasone (25%) and azithromycin (25%). Twenty (29%) patients required oxygen therapy via high-flow nasal cannula, 15 (22%) patients required non-invasive mechanical ventilation or invasive mechanical ventilation with a median time of 5 days. Mechanic ventilation was more frequently applied in non-survivors (40% vs. 7%, p<0.001). A total of 27% of patients were admitted to ICU with a median time of 5.5 days. Twenty-five (37%) patients had the late-stage disease, and it was more frequently in non-survivors than in survivors (60% vs. 23%, p = 0.002). Baseline characteristics of the cancer patients were summarized in Table 1.

Non-survivors had lower lymphocyte count (8.2 vs. 13 109/L, p = 0.03), albumin level (2.8 vs. 3.5 g/dL, p = 0.003), but higher lactate dehydrogenase (501 vs. 371 U/L, p = 0.04), C-reactive protein (21.6 vs. 7.9 mg/dL, p = 0.01), fibrinogen (736 vs. 587 mg/dL, p = 0.02), troponin (0.15 vs. 0.01, p = 0.009), and ferritin (697 vs. 531.5 ng/mL, p = 0.03) levels compared to survivors. Laboratory findings were summarized in Table 2.

On multivariable logistic regression analysis, increasing age (OR 1.20 [95% CI 1.04–1.38], p = 0.01), and mechanical ventilation (OR 32.2 [95% CI 3.73–307.5], p = 0.003) were associated with increased odds of death (Table 3). There was no association between gender, obesity status, comorbidity score, anti-cancer therapy, stage of disease, and death.

Discussion

In this retrospective, single-center cohort study, we reported demographic, clinical, and laboratory findings, as well as treatments and outcomes, for 68 patients with cancer and laboratory-confirmed COVID-19 infection. Patients with cancer appear to have an increased risk of mortality or severe disease course in the ongoing COVID-19 pandemic regardless of cancer type and antineoplastic treatment. In our cohort, a total of 27% of patients were admitted to ICU, and 37% of the patients died, which is higher than the reported mortality rate in the general population. Similarly, in the literature, few studies reported increased mortality in a cancer patient with COVID-19 disease. In their cohort, Miyashita et al. reported a 28.4% case fatality rate [8]. Another study from Italy reported 20% of the deceased patients with COVID-19 had an active cancer history within the past five years [9]. Similarly, few studies reported increased mortality in cancer patients compared to the general population [10-12]. Although underlying mechanisms are not clearly explained, these findings suggest that patients with cancer are more susceptible to a poor prognosis of COVID-19. Both cancer and patients’ specific risk factors play a vital role in this matter, including impaired immune function and the fragility of cancer patients [13].

Age, gender, and comorbidities are previously reported factors related to mortality in patients with cancer and COVID-19 infection. Similarly, in our study, non-survivors were more likely to be older, male, and black. Additionally, higher comorbidity scores and increased oxygen requirement with NIVM and MV were associated with increased mortality (p values <0.004 and <0.001, respectively). Also, we determined several cancer-specific factors that are related to increased mortality in cancer patients with COVID-19. ECOG performance status of 3 or higher and advanced stage of cancer (Stage 3 and 4) were significantly associated with increased mortality (p values <0.02 and <0.001, respectively). On multivariable logistic regression analysis, only...
Table 1
Baseline characteristics of cancer patients with COVID-19.

| Characteristics          | Overall n = 68 | Survivors n = 43 | Non-survivors n = 25 | p-value |
|--------------------------|---------------|-----------------|----------------------|---------|
| **Age at diagnosis**     |               |                 |                      |         |
| Median                   | 72            | 67 (23–88)      | 77 (56–91)           |         |
| < 75                     | 40 (58.8)     | 32 (74.4)       | 8 (32.0)             |         |
| ≥ 75                     | 28 (41.2)     | 11 (25.6)       | 17 (68.0)            |         |
| **Gender**               |               |                 |                      | 0.086   |
| Male                     | 37 (54.4)     | 20 (46.5)       | 17 (68.0)            |         |
| Female                   | 31 (45.6)     | 23 (53.5)       | 8 (32.0)             |         |
| **Race/Ethnicity**       |               |                 |                      | 0.54    |
| White                    | 23 (33.8)     | 15 (34.9)       | 8 (32.0)             |         |
| Black                    | 36 (52.9)     | 21 (48.6)       | 15 (60.0)            |         |
| Female                   | 31 (45.6)     | 23 (53.5)       | 8 (32.0)             |         |
| **Comorbidity Score**    |               |                 |                      |         |
| ≤ 3                      | 29 (42.6)     | 24 (55.8)       | 5 (20.0)             |         |
| > 3                      | 39 (57.4)     | 19 (44.2)       | 20 (80.0)            |         |
| **Obesity status**       |               |                 |                      | 0.52    |
| Normal                   | 24 (35.3)     | 13 (30.2)       | 11 (44.0)            |         |
| Overweight (BMI ≥ 25)    | 25 (36.8)     | 17 (39.5)       | 8 (32.0)             |         |
| Obese (≥ 30)             | 19 (27.9)     | 13 (30.2)       | 6 (24.0)             |         |
| **Comorbidity Score**    |               |                 |                      | 0.004   |
| ≤ 3                      | 39 (57.4)     | 19 (44.2)       | 20 (80.0)            |         |
| > 3                      | 29 (42.6)     | 24 (55.8)       | 5 (20.0)             |         |
| **Smoking status**       |               |                 |                      | 0.057   |
| Never smoked             | 44 (64.7)     | 32 (74.4)       | 12 (48.0)            |         |
| Former smoker            | 20 (29.4)     | 10 (23.3)       | 10 (40.0)            |         |
| Current smoker           | 4 (5.9)       | 1 (2.3)         | 3 (12.0)             |         |
| **Type of malignancy**   |               |                 |                      | 0.74    |
| Breast                   | 15 (22.1)     | 12 (27.9)       | 3 (12.0)             |         |
| Prostate                 | 12 (17.6)     | 8 (18.6)        | 4 (16.0)             |         |
| Lung                     | 8 (11.8)      | 4 (9.3)         | 4 (16.0)             |         |
| Colon                    | 7 (10.3)      | 5 (11.6)        | 2 (8.0)              |         |
| Renal                    | 5 (7.4)       | 2 (4.7)         | 3 (12.0)             |         |
| CNS                      | 4 (5.9)       | 3 (6.9)         | 1 (4.0)              |         |
| Melanoma                 | 3 (4.4)       | 2 (4.7)         | 1 (4.0)              |         |
| Hematologic              | 8 (11.8)      | 4 (9.3)         | 4 (16.0)             |         |
| Others                   | 6 (8.8)       | 3 (7.0)         | 3 (12.0)             |         |
| **Insurance status**     |               |                 |                      | 0.002   |
| Medicare Original        | 15 (22.1)     | 7 (16.3)        | 8 (32.0)             |         |
| Medicare MGD             | 33 (48.5)     | 17 (39.5)       | 16 (64.0)            |         |
| Others                   | 20 (29.4)     | 19 (44.2)       | 1 (4.0)              |         |
| **Self-pay/Charity**     | 2 (2.9)       | 2 (4.7)         | 0 (0.0)              |         |
| Medicaid                 | 4 (5.9)       | 3 (6.9)         | 1 (4.0)              |         |
| Commercial               | 8 (11.8)      | 8 (18.6)        | 0 (0.0)              |         |
| Managed care             | 6 (8.8)       | 6 (14.0)        | 0 (0.0)              |         |
| **ECOG performance status** | <0.001 | <0.001 | <0.001 |         |
| ECOG 0-1                 | 35 (51.5)     | 35 (81.4)       | 0 (0.0)              |         |
| ECOG 2                    | 25 (36.8)     | 6 (14.0)        | 19 (76.0)            |         |
| ECOG 3                    | 8 (11.8)      | 2 (4.7)         | 6 (24.0)             |         |
| ECOG 4                    | 46 (67.6)     | 26 (60.5)       | 20 (80.0)            |         |
| **Ant-cancer therapy**   |               |                 |                      | 0.097   |
| None in the 4 weeks before COVID-19 diagnosis | 46 (67.6) | 26 (60.5) | 20 (80.0) |         |
| **Treatment of COVID-19** |               |                 |                      |         |
| Remdesivir               | 16 (23.5)     | 13 (30.2)       | 3 (12.0)             | 0.087   |
| Conv plasma              | 15 (22.1)     | 11 (25.6)       | 4 (16.0)             | 0.35    |
| Tocilizumab              | 3 (4.4)       | 2 (4.7)         | 1 (4.0)              | 0.90    |
| Dexamethasone            | 17 (25.0)     | 16 (37.2)       | 1 (4.0)              | 0.002   |
| Methylpredonisolone      | 20 (29.4)     | 10 (23.3)       | 10 (40.0)            | 0.14    |
| Hydroxychloroquine       | 10 (14.7)     | 4 (9.3)         | 6 (24.0)             | 0.09    |
| Azithromycin             | 17 (25.0)     | 9 (20.9)        | 8 (32.0)             | 0.30    |
| Oxygen requirement       |               |                 |                      | <0.001  |
| Room air or Up to 6 L    | 33 (48.5)     | 30 (69.8)       | 3 (12.0)             |         |
| High flow                | 20 (29.4)     | 10 (23.3)       | 10 (40.0)            |         |
| NIV or MV                | 15 (22.1)     | 3 (7.0)         | 12 (40.0)            |         |
| Mechanical ventilation, days (median) | 5 (7.3) | 5 (7.3) | 5 (7.3) | 0.48   |

In summary, patients with cancer are susceptible to more severe disease course and increased mortality of COVID-19 infection compared to the general population. In addition to generally known risk factors, the high mortality rate in cancer patients with COVID-19 disease is associated with cancer-specific factors such as stage and performance score. This study emphasizes the urgent need for more data, especially in...
Table 2
Laboratory findings of cancer patients with COVID-19.

| Findings (normal range)                              | Overall n = 68 Median levels | Survivors n = 43 | Non-survivors n = 25 | p-value |
|------------------------------------------------------|-----------------------------|------------------|----------------------|---------|
| White blood cell count                               | 7.6 (0.8–24.2)              | 7.3 (0.82–21.0)  | 8.2 (2.0–24.2)       | 0.61    |
| Neutrophils (1.6–6.1 × 10⁹/L)                        | 67.1 (0–95.0)               | 66 (0.38–90.0)   | 75 (0–95.0)          | 0.61    |
| Lymphocytes (1.2–3.8 × 10⁹/L)                        | 11.0 (0.1–80.0)             | 13 (0.01–35.0)   | 8.2 (1.0–80.0)       | 0.03    |
| Neutrophil-lymphocyte ratio                          | 5.7 (0–90.0)                | 4.4 (0.03–90.0)  | 8.4 (0.78–0.0)       | 0.13    |
| Total protein (6.5–8.5 g/dL)                         | 6.8 (4.5–9.6)               | 6.9 (5.4–9.6)    | 6.3 (4.5–8.7)        | 0.07    |
| Albumin (3.5–5.0 g/dL)                               | 3.2 (2.1–4.8)               | 3.5 (2.3–4.8)    | 2.8 (2.1–4.1)        | 0.003   |
| Lactate (0.7–1.9)                                    | 1.5 (0.2–7.2)               | 1.3 (0.2–7.2)    | 2.3 (1.1–5.6)        | 0.15    |
| Lactate dehydrogenase (120–246 U/L)                  | 415 (152.0–1971.0)          | 371.0 (152.0–865.0) | 501 (291–1971) | 0.04    |
| Ferritin (60–140 µg/mL)                              | 60 (24.0–1431.0)            | 55.0 (24.0–1431.0) | 197 (33–486)         | 0.06    |
| ALT (7–50 U/L)                                       | 2.4 (0.5–20.0)              | 2.3 (0.5–14.0)   | 2.8 (0.6–20.0)       | 0.53    |
| C-reactive protein (< 1 mg/dL)                       | 16.2 (0.06–59.0)            | 7.9 (0.06–33.9)  | 21.6 (2.0–59.0)      | 0.01    |
| Procalcitonin (0.00–0.08)                            | 0.25 (0.80–80.0)            | 0.2 (0.5–80.0)   | 0.64 (0.80–0.0)      | 0.07    |
| Troponin (0.000–0.034)                               | 0.037 (0–1.29)              | 0.01 (0–0.36)    | 0.15 (0–1.29)        | 0.009   |
| Sodium (137–145 mmol/L)                              | 137.5 (128.0–164.0)         | 137 (128–164)    | 140 (131–157)        | 0.61    |
| AST (14–36 U/L)                                      | 60.5 (17.0–629.0)           | 54.0 (17.0–153.0) | 74 (26–629)          | 0.20    |
| ALT (0–34 U/L)                                       | 34.5 (4.0–263.0)            | 32.5 (4.0–212.0) | 42 (11–263)          | 0.44    |
| Ferritin (11.1–264 ng/mL)                            | 606.5 (32.4–3912.0)         | 531.5 (32.4–3912.0) | 697 (180–3162) | 0.03    |
| Creatine kinase (30–135 U/L)                         | 651.0 (71–1539)             | 587 (71–833)     | 736 (280–1539)       | 0.02    |
| D-dimer (0–0.45 mg/L)                                | 2.1 (0.5–20.0)              | 2.3 (0.5–14.0)   | 2.8 (0.6–20.0)       | 0.53    |
| BNP (0–899)                                          | 669.0 (71–1539)             | 587 (71–833)     | 736 (280–1539)       | 0.02    |
| Troponin (0.000–0.034)                               | 0.037 (0–1.29)              | 0.01 (0–0.36)    | 0.15 (0–1.29)        | 0.009   |
| Troponin (0.000–0.034)                               | 0.037 (0–1.29)              | 0.01 (0–0.36)    | 0.15 (0–1.29)        | 0.009   |
| Comorbidity Score ≤ 3                                | 0.97 (0.10–8.9)             | 0.97 (0.10–8.9)  | 0.97 (0.10–8.9)      | 0.98    |
| Comorbidity Score > 3                                | 2.87 (0.32–25.6)            | 2.87 (0.32–25.6) | 2.87 (0.32–25.6)     | 0.34    |
| Anti-cancer therapy                                  | 1.20 (1.04–1.38)            | 1.20 (1.04–1.38) | 1.20 (1.04–1.38)     | 0.01    |
| Age at diagnosis (continuous)                        | Ref                         | Ref              | Ref                  | 0.61    |
| Gender                                               | Female                      | 1.19 (0.15–9.38) | 1.19 (0.15–9.38)     | 0.86    |
| Obesity status                                       | Ref                         | Ref              | Ref                  | 0.98    |
| Comorbidity Score ≤ 3                                | Ref                         | Ref              | Ref                  | 0.27    |
| Comorbidity Score > 3                                | Ref                         | Ref              | Ref                  | 0.27    |
| Anti-cancer therapy                                  | Ref                         | Ref              | Ref                  | 0.27    |
| None in the 4 weeks before COVID-19 diagnosis        | Ref                         | Ref              | Ref                  | 0.27    |
| Within 4 weeks before COVID-19 diagnosis             | Ref                         | Ref              | Ref                  | 0.27    |
| Oxygen requirement                                   | Ref                         | Ref              | Ref                  | 0.27    |
| Room air or Up to 6 L                                | Ref                         | Ref              | Ref                  | 0.27    |
| High flow                                            | Ref                         | Ref              | Ref                  | 0.27    |
| NIVM or MV                                           | Ref                         | Ref              | Ref                  | 0.27    |
| Stage i–II                                           | Ref                         | Ref              | Ref                  | 0.27    |
| OR; Odds ratio, CI; Confidence interval              | Ref                         | Ref              | Ref                  | 0.27    |

Funding sources and disclosures

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

Muhammet Ozer: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Writing - original draft, Writing - review & editing.
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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments:
None.

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