One-Year and Consequences of COVID-19 in Cancer Patients: a Cohort Study

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Abstract

Background

The study aim was to investigate one-year all-cause mortality and health consequences of cancer COVID-19 patients in China, stratified by primary tumor subtype.

Methods

In this multicenter cohort study, 166 cancer COVID-19 patients were studied along with 498 gender- and age-matched non-cancer COVID-19 patients in four hospitals in Wuhan, China, admitted 2020/01/01-2020/03/18, as well as with 498 parallel gender-, age-, and cancer subtype-matched non-COVID cancer patients hospitalized between 2019/01/01-2020/03/17. All patients were followed-up with a telephone survey to assess health consequences. Cox proportional hazards regression were used for risk analysis.

Results

In the three cohorts of median age of 65 ± 1 year and 49% male, the one-year all-cause mortality and hospital mortality rates of Cancer COVID-19 Cohort, 30% and 20% respectively, were significantly higher than COVID-19 Cohort (9% and 8%), and Cancer Cohort (16% and 2%). The 12-month all-cause post-discharge mortality rate of Cancer COVID-19 Cohort (11%) was higher than COVID-19 Cohort (0.4%), but similar to Cancer Cohort (15%). The high 1-year all-cause mortality was among hematologic malignancies (65%) and then nasopharyngeal, brain and skin tumors (45%), digestive system (43%), and lung (32%). The rate was low among genitourinary (14%), female genital (13%), breast (11%), and thyroid (0). As for patients having at least one symptom at the 1-year follow-up, Cancer COVID-19 Cohort (23%, 26/114) is similar to COVID-19 Cohort (30%, 130/432).

Discussion

Cancer COVID-19 patients showed a high rate of hospitalization mortality, but not after discharged, signifying the strong acute adverse effect of COVID-19 on cancer patients while little was in long-term effect. Risk stratification showed that hematologic malignancies, nasopharyngeal, brain, digestive system and lung tumors were high risk, while genitourinary, female genital, breast and thyroid were low risk which was similar to non-cancer COVID-19.

Conclusions

COVID-19 had little effect of 1-year mortality and sequelae for cancer survivors discharged from SARS-CoV-2 virus infection. Different tumor subtypes had different effect of COVID-19. COVID-19 patients with
thyroid, breast, female genital, genitourinary tumor had low risk mortality which was similar to non-cancer patients.

**Background**

As of 30 March 2021, the number of COVID-19 cases and deaths continued to rise with 127.3 million cumulative cases and 2.8 million deaths globally[1]. The global cancer burden is estimated to have risen to 19.3 million new cases and 10.0 million deaths in 2020[2]. Initial reports suggested that patients with active malignancy might be at increased risk of contracting SARS-CoV-2 and have an increasing risk of short-term mortality[3–6].

However, these initial reports were restricted by follow-up time[6]. As some patients remained hospitalized for some time, longer-term follow-up is needed to better understand the effect of COVID-19 on outcomes in cancer patients[6, 3, 7]. Cancer encompasses a diverse array of primary tumor subtypes with different outcomes[8, 9]. To the best of our knowledge, there are no reports to study long-term prognostic of cancer patients with COVID-19, and few studies comparing them with cancer patients without COVID-19, and with different tumor subtypes.

To address this knowledge gap, we compared 166 cancer patients with COVID-19 with 498 COVID-19 patients without cancer, and with 498 cancer patients without COVID-19 from 4 hospitals in Wuhan, a China ‘hot spot’ of COVID-19. All survival patients were followed up for at least 12 months post hospital admission.

**Methods**

**Study Design and Patients**

In this multicenter ambidirectional comparative cohort study, we enrolled sequential cancer patients who were admitted with COVID-19 (Cancer COVID-19 Cohort) to the four hospitals in Hubei Province, China, the epicenter of the first COVID-19 outbreak, between January 1, 2020, and March 18, 2020 (Supplementary Table 1). Eligibility criteria for enrollment were laboratory confirmation of SARS-CoV-2 virus infection by RT-PCR test and hospitalized patients with active cancer (Supplementary Table 2). COVID-19 disease severity was defined according to WHO guidelines[10]. Primary tumor subtypes were classified by the World Health Organization (WHO) Classification of Tumors series[11]. Each Cancer COVID-19 patient was matched in a 1:3 ratio based on age (± 5 years) and sex, to a comparator patient without cancer from the same COVID-19-positive population (COVID-19 Cohort). Another parallel comparator patient served as uninfected controls were chosen in a 1:3 ratio with age (± 5 years), gender, and cancer subtype, from cancer patients admitted to the same four hospitals between January 1, 2019 and March 17, 2020. All data were de-identified. This study was done in accordance with the STROBE statement[12].

**Study Variables and Outcomes**
We define the acute phase as the time between symptom onset and hospital discharge. Data were collected on site by trained coordinators manually reviewing the electronic medical records and importing into a secure online database using a standardized case report form (Supplementary Case Report Form). Demographic characteristics, coexisting conditions, presenting symptoms, vital signs, biochemical finding, treatment practices, and a variety of hospital outcome data were collected. To ensure enrollment of an unbiased population, the consecutive eligible patients were recruited from each site from Jan 1, 2020, to March 17, 2020.

All survivors who had discharged from hospital were selected onto follow-up study to observe their health consequences in recovery from COVID-19 (Supplementary Follow-Up Studies). Some patients were done follow-up interview in outpatient clinic and asked to complete a series of questionnaires. We followed up patients until death, or February 18, 2021, whichever came first.

The primary outcomes included the 1-year all-cause mortality rate, sequelae. Secondary outcomes variables included: the hospital mortality rate, the length of hospital stay, and the 12-month all-cause post-discharge mortality rate.

**Statistical Analysis**

We aimed to generate a representative sample of cancer patients with COVID-19 by starting with at least 5,500 patients with COVID-19 and 38335 cancer patients from the four hospitals (Supplementary Fig. 1). To describe baseline characteristics, treatment, and outcome, we prespecified the following covariates for inclusion in the models. Continuous variables were presented as median and interquartile range [IQR] while categorical variables presented as number (percentage).

The Kaplan-Meier method with log-rank test was used for comparing survival curves between Cancer COVID-19 Cohort and control groups. Cox proportional hazards regression was used to investigate the effect of several risk factors on survival. Univariable and multivariable analyses between 1-year mortality and risk factors were performed. The risk factor variables were included in the stepwise Cox proportional hazards regression. A backward stepwise technique evaluated all potential univariable correlates (p < 0.05) to create a multivariable model containing variables with p < 0.05.

Analyses were performed using SPSS Statistics 26.0 software (International Business Machines Corp, IBM) and Graph Pad Prism, Version 8.0.2 (GraphPad Software, Inc.).

**Results**

**Patient Characteristics at Baseline**

The 166 hospitalized cancer COVID-19 patients had the median age of 65 years (59-70) and 49% (82/166) patients were male (Table 1). The patients consists of different primary tumor subtypes following WHO classification criteria (Table 2)[13]; most cases were of the digestive system (25%, 42/166), followed by the lung (15%, 25/166), and genitourinary (13%, 22/166); in terms of primary organ,
Lung cancer was the most frequently observed cancer type (15%, 25/166), followed by breast (11%, 19/166), and colon cancer (11%, 18/166).

At baseline, demographics characteristics of patients were well-balanced in all three cohorts (Table 1). Comorbidities among Cancer COVID-19 Cohort were generally similar with those among COVID-19 Cohort. But comparing to Cancer Cohort, Cancer COVID-19 Cohort were more likely to have diabetes (9% vs 15%, P=.07), hyperlipidemia (7% vs 20%, P<.001), hyperuricemia (3% vs 10%, P<.001), and COPD (1% vs 7%, P=.001), supporting the risks of these underlying conditions for COVID-19.

In terms of COVID-19 symptoms, Cancer COVID-19 Cohort were more likely to have expectoration (21% vs 36%, P<.001), dyspnea (16% vs 24%, P=.017), and consciousness disorder (4% vs 11%, P=.001) than COVID-19 Cohort, but less likely to have a sore throat (14% vs 7%, P=.02) or dry cough (53% vs 43%, P=.031) (Table 1). Cancer COVID-19 Cohort showed more severe complications such as Respiratory failure (16% vs 10%, P=.045), acute kidney injury (18% vs 8%, P=.001) and acute liver injury (32% vs 22%, P=.011) than COVID-19 Cohort (Table 1). Cancer COVID-19 Cohort presented with a higher level of C-reactive protein, white blood cell count, globulin protein, Aspartate transaminase, blood urea nitrogen, and blood glucose than COVID-19 Cohort (P<.05), whereas red blood cell count, albumin protein, and high-density lipoprotein decreased (P<.05) (Supplementary Table 3).

One-year All-Cause Mortality

Median follow-up time from the point of hospital admission was 12.2 (IQR 12.1-12.6) months (Table 3). In the Cox proportional hazards regression analysis, 30% (49/166) Cancer COVID-19 Cohort died within 12 months. It was 9% (44/498) in COVID-19 Cohort (relative risk=0.29; 95% CI 0.19 to 0.44, P<0.001), for an absolute risk difference of -19 percentage points (95% CI -13 to -29, P<0.001). The mortality was 16% (80/498) for Cancer Cohort (RR, 0.43; 95% CI 0.30 to 0.62, P<0.001), for an absolute risk difference of -13 percentage points (95% CI -9 to -19, P<.001). Results were similar in the adjusted analysis. Figure 1A shows the main difference between Cancer COVID-19 Cohort and Cancer Cohort was in the first 2 months, 20% (34/166) and 4% (20/498). Between COVID-19 Cohort and Cancer Cohort, no statistical difference detected in the 3- to 4-month mortality (3.4 months being the time point where the two cohorts had same death rate), and 1-year mortality among COVID-19 Cohort was lower than that of Cancer Cohort (RR, 0.49; 95% CI 0.34 to 0.71, P<0001).

One-year Health Consequences

At the 1-year followed up, 56 cancer COVID-19 patients were excluded because 49 patients died and 7 patients couldn't be reached; 70 COVID-19 patients were excluded because 44 patients died and 26 patients not reachable. As the result, 114 cancer COVID-19 patients and 432 COVID-19 participants were enrolled for questionnaire interview. In terms of having at least one symptom at the follow-up, the rate was 23% (26 /114) among Cancer COVID-19 Cohort, generally similar with the rate of 30% (130/432) in COVID-19 Cohort. Interesting, cancer COVID-19 Cohort were slightly little likely to have fatigue (4%, 12%, P=.016), chest congestion (3%, 9%, P=.027), and anxiety (0, 5%, P=.021) than COVID-19 Cohort (Table 3).
**Hospital Mortality**

Median length of hospital stay of 25 (IQR 15-33) days among Cancer COVID-19 Cohort was longer than the 21 (IQR 11-28) days for COVID-19 Cohort (Supplementary Table 4) (P=.005). Cancer COVID-19 Cohort were more severe COVID-19 (36% vs 20%, P<.001) than COVID-19 Cohort (Table 3). Cancer COVID-19 Cohort also required significantly more mechanical ventilation (14% vs 6%, P<0.001). Death in hospital occurred in 34/166 (20%) cancer COVID-19 patients; in 42/498 (8%) COVID-19 Cohort (relative risk, 0.36; 95% CI 0.22 to 0.59, P<0.001); and in 8/498 (2%) in Cancer Cohort (RR, 0.10; 95% CI 0.05 to 0.19, P<0.001).

**Twelve-Month Post-Discharge Mortality**

Median follow-up of cancer COVID-19 patients from the point of hospital discharged was 11.2 (IQR 10.8–11.6) months among who were discharged alive (Table 3 and Figure 1B). The 12-month all-cause post-discharge mortality rate was 11% (15/132) for Cancer COVID-19 Cohort, significantly higher than 0.4% (2/456, P<0.001) for COVID-19 Cohort, and showing no statistical difference from 15% (73/490, P=0.084) of Cancer Cohort.

**Outcomes of Primary Tumor Subtype**

For 1-year mortality, comparing to COVID-19 Cohort (9%, 44/498), COVID-19 patients with hematologic malignancies (65%, 11/17, P<0.001) had the highest rate, followed by a few solid such as brain/nasopharyngeal/bone and skin (45%, 5/11, P<0.001), digestive system tumors (43%, 18/42, P<0.001), and lung (32%, 8/25, P<0.001); COVID-19 patients with breast and endocrine tumors were associated with relatively low mortality (6%, 2/33, P=0.57), while patients with female genital tumors (13%, 2/16, P=0.43) and genitourinary (14%, 3/22, P=0.61) had moderate high mortality rate (Table 2 and Figure 2). Compared with the COVID-19 Cohort, patients with hematologic, brain, nasopharyngeal, digestive system and lung malignancies, combined as first group, showed a significantly higher risk of 1-year post admission mortality [5.7(3.8-8.8), P<0.001] and 12-month post discharge mortality [55.7(12.6-245.3), P<0.001]; patients with breast and endocrine, genitourinary and female genital tumors combined as second group, showed moderate risk of 1-year post admission mortality [1.1 (0.5-2.5), P=0.79] and 12-month post discharge mortality [3.6 (0.3-39.3), P=0.299] (Figure 2).

**Risk Factors for Outcomes of Cancer COVID-19 Cohort**

In the multivariate cox regression model (Figure 3), we observed that male [HR 2.0, 95% CI 1.1-3.6], severe COVID-19 disease [non-severe; HR 7.5, 95%CI 3.9-14.6], hyperuricemia [HR 3.9, 95% CI 1.8-8.2], stroke [HR 3.7, 95% CI, 1.1-12.9], dyspnea [HR 3.1, 95% CI 1.6-5.8], consciousness disorder [HR 9.2, 95% CI, 4.5-18.2], respiratory failure [HR 11.4, 95% CI 5.3-24.6], acute kidney injury [HR 2.2, 95% CI 1.1-4.5] were significantly associated with increased mortality. Analysis characteristics of Cancer COVID-19 Cohort on 1-year all-cause mortality did not show any age bias.
Discussion

To our knowledge, this study represents the longest follow-up on mortality and the health consequences of hospitalized cancer patients with COVID-19. One-year mortality (30%) among Cancer COVID-19 Cohort was nearly 2 times of Cancer Cohort (16%) and more than 3 times of COVID-19 Cohort (9%), even slightly higher than them combined. Compared with the COVID-19 Cohort, patients with hematologic, brain, nasopharyngeal, digestive system, and lung malignancies showed a significantly high risk of mortality. While patients with breast and endocrine, genitourinary and female genital tumors showed moderate risk mortality just similar with the COVID-19 Cohort.

As it was difficult to determine if COVID-19 was the direct cause of death for a patient, or the death was inevitably caused by a terminal event for a patient who was approaching the end of the cancer care, we are reporting the all-cause case fatality rate. All COVID-19 patients in our cohort had finished their clinical course. The hospital mortality among the Cancer COVID-19 Cohort was 20%, which was 2.5 times of the COVID-19 Cohort (8%) and was higher than the Cancer Cohort (2%). The difference of hospital mortality among the three cohorts shows the strong adverse effect of COVID-19 on both cancer and non-cancer patients. A cohort study reported a death rate of 20% (40/205) in patients with cancer and COVID-19 in Hubei, China[3]. A series of 218 cancer patients with COVID-19 patients with cancer from a New York Hospital System reported a case fatality rate of 28% because of a bias towards more severe cases[5]. It signifies the acute adverse effect of COVID-19, by it alone, and even stronger while combined with cancer[6]. Provided that our non-cancer control cohort is age- and gender- matched with our cancer COVID-19 Cohort, the risk factors of age and gender had been excluded.

Our results showed that different tumor subtypes among Cancer COVID-19 Cohort had different outcomes. Comparing with COVID-19 Cohort, Cancer COVID-19 Cohort with hematologic malignancies, nasopharyngeal, brain, digestive system and lung tumors had high risk by stratification analysis of mortality; while thyroid and endocrine, genitourinary and female genital tumors were moderate risk. This is consistent with a few other studies: COVID-19 patients with hematologic malignancies were reported to have high mortality rate in China(41% – 62%)[3, 14], USA (37%, 20/54)[5], UK (36%, 81/224)[8] and Spain (33%, 230/697)[15]; thoracic cancer COVID patients were reported with high mortality rate in The Thoracic Cancers International COVID-19 Collaboration (TERAVOLT) registry (33%, 66/200)[16], China (25%, 6/24)[3], USA (55%, 6/11)[5], UK (39%, 43/111)[8] and Turkey [11, 18/157 (vs total cancers 4%, 50/1122)][17]; digestive system tumors were associated with high mortality rate in China(23%, 9/40)[3], USA (38%, 15/39)[5], UK (30%, 63/219)[8]; and COVID-19 patients with breast, thyroid or endocrine tumors had lower mortality rate in China(7%, 4/56) [3], USA (13%, 4/31) [5], UK (18%, 26/143)[8], and Turkey (1%, 4/442) [17]. However, COVID-19 patients with genitourinary or gynecologic tumors, showing generally low mortality rate in our study with very small sample size, had different outcomes in other studies (genitourinary: low in USA, 15%, 7/46; high in UK, 38%, 72/191; gynecologic, high in USA 38%, 5/13; low in UK 13%, 7/56)[8, 5]. As the UK study had the bigger sample size, it might be more representative.
We found that at 12 months after hospital admission, 23% cancer COVID-19 patients endorsed at least one symptom, which had similar risk with 30% of COVID-19 Cohort. Cough (9%) or dyspnea (8%) were common among Cancer COVID-19 Cohort, while fatigue (12%) or chest congestion (9%) were common in COVID-19 Cohort. Huang and colleagues found that Fatigue or muscle weakness (63%) were the most common symptoms in a 6-month follow-up survey of 1733 COVID-19 patients[17]. A 3-month follow-up survey of 538 COVID-19 patients reported that Fatigue (28%) were the most common symptoms in[18].

Interesting, we found that fatigue, depression or anxiety, and chest congestion were more common in COVID-19 Cohort than Cancer COVID-19 Cohort.

Many of the predictive risk factors for mortality in the Cancer COVID-19 Cohort were similar to data reported among all patients with COVID-19[19]. In the adjusted Cox proportional hazards model, we observed significant associations of death from COVID-19 patients with chronic diseases including hypertension, diabetes, hyperuricemia, COPD, cardiovascular disease, and cerebrovascular disease[20, 21]. Serologic predictors in our dataset predictive for mortality included anemia at the time of infection, and elevated LDH, D-dimer, and lactic acid, which correlated with available data from all COVID-19 patients[22].

**Limitation**

This study has several limitations. First of all, this study population only included hospitalized COVID-19 patients within Hubei Province, China, therefore, the cohort might not exactly represent all cancer patient population, such as patients who were on end-of-life care and/or residing in nursing homes, which may potentially bias our study to more severe cases of COVID-19. Secondly, our Cancer Cohort were admitted into hospital for active cancer during a different time frame (01/01/2019-03/17/2020) from the COVID-19 Cohorts (01/01/2020-03/17/2020), the hospitals might be under different stress levels and operation modes during these two time frames, although it shouldn’t affect the patient care significantly. Nonetheless it would be desired to use contemporaneous control groups when these data become available. Lastly it would be ideal to have cancer stages identified and matched between cohorts in addition to the cancer subtypes. However, the cancer staging information required extensive manual review and verifications, eventually becoming prohibitively time-consuming and technically difficult for the involved COVID-19 clinicians to collect and confirm on, especially on the deceased patients. Also the sample size of stratified populations would be too limited to be meaningful. Hopefully our larger sample size of controls compensates some of the potential skews.

**Conclusion**

Our data showed a significant increase in mortality among cancer patients with COVID-19, especially in higher risk group, patients with hematologic, brain, nasopharyngeal, digestive system and lung malignancies. It supports that, as an acute respiratory infectious disease, COVID-19 brings a high risk on cancer patients in the acute phase of the disease, but it probably does not affect the long-term prognosis of patients after they are discharged from hospital.
COVID-19 had little effect of 1-year mortality and sequelae for cancer survivors discharged from SARS-CoV-2 virus infection. Different tumor subtypes had different effect of COVID-19. COVID-19 patients with thyroid, breast, female genital, genitourinary tumor had low risk mortality which was similar to non-cancer patients.

**Abbreviations**

COVID-19: Coronavirus disease 2019; RT-PCR: Reverse Transcriptase Polymerase Chain Reaction; SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus 2; WHO: World Health Organization; IQR: Interquartile range; CI: Confidence interval; RR: Relative Risk; HR: Hazard Ratio; USA: The United States of America; UK: United Kingdom; LDH: Lactic dehydrogenase; HFNC: High low nasal cannula; NIV: Non-invasive ventilation; IMV: Invasive mechanical ventilation; ECMO: Extracorporeal membrane oxygenation; ALT: Alanine transaminase; AST: Aspartate transaminase; CRRT: Continuous renal replacement therapy; RR: Respiratory rate; FiO2: Fraction of inspired oxygen; PaO2: Partial pressure of oxygen; PEEP: Positive end-expiratory pressure; CPAP: Continuous positive airway pressure; ICU: Intensive care unit; DVT: Deep vein thrombosis; eGFR: Estimated glomerular filtration rate; PE: Pulmonary embolism; COPD: Chronic obstructive pulmonary disease; CHD: Coronary Heart Disease; APTT: Activated partial thromboplastin time.

**Declarations**

**Ethics approval and consent to participate**

The study was approved by the Institutional Ethics Committee of Union Hospital (2021-0005-01) and Institutional Ethics Committee of the Central Hospital of Wuhan (2020-7), Tongji Medical College, Huazhong University of Science and Technology. The data used were de-identified. No reference has been made at any point to individually identifiable data. All of the data used in this study come from Wuhan Union Hospital and its affiliated hospitals and the Central Hospital of Wuhan.

**Consent for publication**

Not applicable.

**Availability of data and materials**

The datasets generated and/or analysed during the current study are not publicly available due Data Protection Laws and Regulations in China but are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.
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Role of the funder

The funder had no role in the design of the study; the collection, analysis, and interpretation of the data; the writing of the manuscript; and the decision to submit the manuscript for publication.

Conflicts of interests

All authors declare no potential conflicts of interests.

Availability of data and material

The data underlying this article cannot be shared publicly because subsequent follow-up investigations for COVID-19 are in progress. The data will be shared on reasonable request to the corresponding author.

Author Contributions

ZT, YW, JZ, CC conceived the project; XF, ML, SL, KC, HW, WW, ZT, GC, XW, YL, YW, BD, HF, LW, FA, WL, CP, HZ, SW analyzed the data; ZT, CC, XF, ML, SL, KC, HW, WW extracted data and generated figures; ZT, CC, XF, ML, SL, KC, HW, WW wrote the manuscript which was reviewed and edited by the other co-authors.

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References

1. World Health Organization (2021) WHO Coronavirus Disease (COVID-19) Dashboard. WHO Health Emergency Dashboard. https://covid19.who.int/ . Accessed March 31, 2021
2. The International Agency for Research on Cancer of World Health Organization (2020) Latest global cancer data: Cancer burden rises to 19.3 million new cases and 10.0 million cancer deaths in 2020. https://www.iarc.fr/faq/latest-global-cancer-data-2020-qa/ . Accessed 30 December 2020
3. Yang KY, Sheng YH, Huang CL, Jin Y, Xiong N, Jiang K, Lu HD, Liu J, Yang JY, Dong YH, Pan DF, Shu CR, Li J, Wei JL, Huang Y, Peng L, Wu MJ, Zhang RG, Wu B, Li YH, Cai LQ, Li GL, Zhang T, Wu G (2020) Clinical characteristics, outcomes, and risk factors for mortality in patients with cancer and COVID-19 in Hubei, China: a multicentre, retrospective, cohort study. Lancet Oncol 21 (7):904-913. doi:10.1016/s1470-2045(20)30310-7
4. Dai M, Liu D, Liu M, Zhou F, Li G, Chen Z, Zhang Z, You H, Wu M, Zheng Q, Xiong Y, Xiong H, Wang C, Chen C, Xiong F, Zhang Y, Peng Y, Ge S, Zhen B, Yu T, Wang L, Wang H, Liu Y, Chen Y, Mei J, Gao X, Li Z, Gan L, He C, Li Z, Shi Y, Qi Y, Yang J, Tenen DG, Chai L, Mucci LA, Santillana M, Cai H (2020) Patients with Cancer Appear More Vulnerable to SARS-CoV-2: A Multicenter Study during the COVID-19 Outbreak. Cancer Discov 10 (6):783-791. doi:10.1158/2159-8290.CD-20-0422

5. Mehta V, Goel S, Kabarriti R, Cole D, Goldfinger M, Acuna-Villaorduna A, Pradhan K, Thota R, Reissman S, Sparano JA, Gartrell BA, Smith RV, Ohri N, Garg M, Racine AD, Kalnicki S, Perez-Soler R, Halmos B, Verma A (2020) Case Fatality Rate of Cancer Patients with COVID-19 in a New York Hospital System. Cancer Discovery 10 (7):935-941. doi:10.1158/2159-8290.Cd-20-0516

6. Kuderer NM, Choueiri TK, Shah DP, Shyr Y, Rubinstein SM, Rivera DR, Shet S, Hsu CY, Desai A, Lopes GD, Grivas P, Painter CA, Peters S, Thompson MA, Bakouny Z, Batist G, Bekaii-Saab T, Bilan MA, Bouganim N, Larroya MB, Castellano D, Del Prete SA, Doroshow DB, Egan PC, Elkrief A, Farmakiotis D, Flora D, Galsky MD, Glover MJ, Griffiths EA, Gulati AP, Gupta S, Hafez N, Halfdanarson TR, Hawley JE, Hsu E, Kasi A, Khaki AR, Lemmon CA, Lewis C, Logan B, Masters T, McKay RR, Mesa RA, Morgans AK, Mulcahy MF, Panagiotou OA, Peddi P, Pennell NA, Reynolds K, Rosen LR, Rosovsky R, Salazar M, Schmidt A, Shah SA, Shaya JA, Steinharter J, Stockerl-Goldstein KE, Subbiah S, Vinh DC, Wehbe FH, Weissmann LB, Wu JTY, Wulf-Burcheld E, Xie ZE, Yeh A, Yu PP, Zhou AY, Zubiri L, Mishra S, Lyman GH, Rini BI, Warner JL, Consortium C-C (2020) Clinical impact of COVID-19 on patients with cancer (CCC19): a cohort study. Lancet 395 (10241):1907-1918. doi:10.1016/s0140-6736(20)31187-9

7. Yelin D, Wirtheim E, Vetter P, Kalil AC, Bruchfeld J, Runold M, Guaraldi G, Mussini C, Gudiel C, Pujol M, Bandera A, Scudeller L, Paul M, Kaiser L, Leibovici L (2020) Long-term consequences of COVID-19: research needs. Lancet Infectious Diseases 20 (10):1115-1117. doi:10.1016/s1473-3099(20)30701-5

8. Lee LYW, Cozier J-B, Starkey T, Briggs SEW, Arnold R, Bisht V, Booth S, Campton NA, Cheng VWT, Collins G, Curley HM, Earwaker P, Fittall MW, Gennatas S, Goel A, Hartley S, Hughes DJ, Kerr D, Lee AJX, Lee RJ, Lee SM, McKenzie H, Middleton CP, Murugaesu N, Newsom-Davis T, Olsson-Brown AC, Palles C, Powles T, Protheroe EA, Purshouse K, Sharma-Oates A, Sivakumar S, Smith AJ, Topping O, Turnbull CD, Varnai C, Briggs ADM, Middlenton G, Kerr R, Pro UKCCM (2020) COVID-19 prevalence and mortality in patients with cancer and the effect of primary tumour subtype and patient demographics: a prospective cohort study. Lancet Oncol 21 (10):1309-1316. doi:10.1016/s1470-2045(20)30442-3

9. Plass C (2020) A new series of Invited Reviews on WHO tumor classification. International Journal of Cancer 146 (12):3243-3243. doi:10.1002/ijc.32983

10. Huang C, Huang L, Wang Y, Li X, Ren L, Gu X, Kang L, Guo L, Liu M, Zhou X, Luo J, Huang Z, Tu S, Zhao Y, Chen J, Xu D, Li Y, Li C, Peng L, Li Y, Xie W, Cui D, Shang L, Fan G, Xu J, Wang G, Wang Y, Zhong J, Wang C, Wang J, Zhang D, Cao B (2021) 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. Lancet 397 (10270):220-232. doi:10.1016/S0140-6736(20)32656-8

11. World Health Organization (2020) Clinical management of severe acute respiratory infection when Novel coronavirus (nCoV) infection is suspected: interim guidance.
12. Sharp MK, Glonti K, Hren D (2020) Online survey about the STROBE statement highlighted diverging views about its content, purpose, and value. Journal of Clinical Epidemiology 123:100-106. doi:10.1016/j.jclinepi.2020.03.025

13. Uttley L, Indave BI, Hyde C, White V, Lokuhetty D, Cree I (2020) Invited commentary-WHO Classification of Tumours: How should tumors be classified? Expert consensus, systematic reviews or both? International Journal of Cancer 146 (12):3516-3521. doi:10.1002/ijc.32975

14. He W, Chen L, Chen L, Yuan G, Fang Y, Chen W, Wu D, Liang B, Lu X, Ma Y, Li L, Wang H, Chen Z, Li Q, Gale RP (2020) COVID-19 in persons with haematological cancers. Leukemia 34 (6):1637-1645. doi:10.1038/s41375-020-0836-7

15. Garcia-Suarez J, de la Cruz J, Cedillo A, Llamas P, Duarte R, Jimenez-Yuste V, Hernandez-Rivas JA, Gil-Manso R, Kwon M, Sanchez-Godoy P, Martinez-Barranco P, Colas-Lahuerta B, Herrera P, Benito-Parra L, Alegre A, Velasco A, Matilla A, Alaez-Uson MC, Martos-Martinez R, Martinez-Chamorro C, Susana-Quiroz K, Del Campo JF, de la Fuente A, Herraez R, Pascual A, Gomez E, Perez-Oteyza J, Ruiz E, Alonso A, Gonzalez-Medina J, Martin-Buitrago LN, Canales M, Gonzalez-Gascon I, Vicente-Ayuso MC, Valenciano S, Roa MG, Montelius PE, Lopez-Jimenez J, Escobar CE, Ortiz-Martin J, Diez-Martin JL, Martinez-Lopez J, Assoc Madrilena Hematologia H (2020) Impact of hematologic malignancy and type of cancer therapy on COVID-19 severity and mortality: lessons from a large population-based registry study. Journal of Hematology & Oncology 13 (1):133-146. doi:10.1186/s13045-020-00970-7

16. Garassino MC, Whisenant JG, Huang LC, Trama A, Torri V, Agustoni F, Baena J, Banna G, Berardi R, Bettini AC, Bria E, Brighenti M, Cadranel J, De Toma A, Chini C, Cortellini A, Felip E, Finocchiaro G, Garrido P, Genova C, Giusti R, Gregorc V, Grossi F, Grosso F, Intagliata S, La Verde N, Liu SV, Mazieres J, Mercadante E, Michielin O, Minuti G, Moro-Sibilot D, Pasello G, Passaro A, Scotti V, Solli P, Stroppa E, Tiseo M, Viscardi G, Voltolini L, Wu YL, Zai S, Pancaldi V, Dingemans AM, Van Meerbeeck J, Barlesi F, Wakelee H, Peters S, Horn L, Investigators T (2020) COVID-19 in patients with thoracic malignancies (TERAVOLT): first results of an international, registry-based, cohort study. Lancet Oncol 21 (7):914-922. doi:10.1016/s1470-2045(20)30314-4

17. Özdemir N, Dizdar Ö, Yazıcı O, Aksoy S, Dede DS, Budakoğlu B, Metan G, Alp A, Budakoğlu II, Öksüzoglu ÖBÇ, Özet A, Kılıçkap S, Turhal NS, Çelik İ, Erman M, Ata N, Çelik O, Hayran M (2021) Clinical features and outcomes of COVID-19 in patients with solid tumors: Turkish National Registry Data. International Journal of Cancer 148 (10):2407-2415. doi:https://doi.org/10.1002/ijc.33426

18. Xiong Q, Xu M, Li J, Liu Y, Zhang J, Xu Y, Dong W (2021) Clinical sequelae of COVID-19 survivors in Wuhan, China: a single-centre longitudinal study. Clinical Microbiology and Infection 27 (1):89-95. doi:10.1016/j.cmi.2020.09.023

19. Wiersinga WJ, Rhodes A, Cheng AC, Peacock SJ, Prescott HC (2020) Pathophysiology, Transmission, Diagnosis, and Treatment of Coronavirus Disease 2019 (COVID-19): A Review. JAMA 324 (8):782-793. doi:10.1001/jama.2020.12839
20. Gupta S, Hayek SS, Wang W, Chan L, Mathews KS, Melamed ML, Brenner SK, Leonberg-Yoo A, Schenck EJ, Radbel J, Reiser J, Bansal A, Srivastava A, Zhou Y, Sutherland A, Green A, Shehata AM, Goyal N, Vijayan A, Velez JCQ, Shaefi S, Parikh CR, Arunthamakun J, Athavale AM, Friedman AN, Short SAP, Kibbelaar ZA, Abu Omar S, Admon AJ, Donnelly JP, Gershengorn HB, Hernan MA, Semler MW, Leaf DE, Investigators S-C (2020) Factors Associated With Death in Critically Ill Patients With Coronavirus Disease 2019 in the US. JAMA internal medicine 180 (11):1-12. doi:10.1001/jamainternmed.2020.3596

21. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, Northwell C-RC (2020) Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. Jama-J Am Med Assoc 323 (20):2052-2059. doi:10.1001/jama.2020.6775

22. Harrison SL, Fazio-Eynullayeva E, Lane DA, Underhill P, Lip GYH (2020) Comorbidities associated with mortality in 31,461 adults with COVID-19 in the United States: A federated electronic medical record analysis. Plos Medicine 17 (9):e1003321. doi:10.1371/journal.pmed.1003321

Tables
| Demographics                  | Cancer COVID-19 Cohort (n=166) | COVID-19 Cohort (n=498) | P Value  | Cancer Cohort (n=498) | P Value |
|------------------------------|---------------------------------|-------------------------|----------|-----------------------|---------|
| Age, median (IQR), y         | 65(59-70)                       | 65(59-70)               | 1.000    | 66(58-73)             | .49     |
| Sex                          |                                 |                         |          |                       |         |
| Female                       | 84(51)                          | 252(51)                 | 1.000    | 252(51)               | 1.000   |
| Male                         | 82(49)                          | 246(49)                 |          | 246(49)               |         |
| Comorbidities                |                                 |                         |          |                       |         |
| Current smoking              | 8(5)                            | 14(3)                   | .211     | 127(26)               | <.001   |
| Hypertension                 | 55(33)                          | 171(34)                 | .777     | 135(27)               | .137    |
| Diabetes                     | 24(15)                          | 104(21)                 | .069     | 47(9)                 | .07     |
| Hyperlipidemia               | 33(20)                          | 76(15)                  | .164     | 34(7)                 | <.001   |
| Hyperuricemia                | 16(10)                          | 42(8)                   | .634     | 14(3)                 | <.001   |
| Coronary heart disease       | 12(7)                           | 40(8)                   | .739     | 53(11)                | .2      |
| Cerebrovascular disease      | 4(2)                            | 18(4)                   | .453     | 14(3)                 | 1.000   |
| COPD                         | 11(7)                           | 25(5)                   | .429     | 7(1)                  | .001    |
| Chronic kidney disease       | 3(2)                            | 11(2)                   | 1.000    | 7(1)                  | 1.000   |
| Chronic liver disease        | 5(3)                            | 7(1)                    | .313     | 28(6)                 | .18     |
| Arrhythmia                   | 8(5)                            | 18(4)                   | .488     | 27(5)                 | .764    |
| Symptoms at admission        |                                 |                         |          |                       |         |
| Fever                        | 118(71)                         | 363(73)                 | .652     | NA                    | NA      |
| Chills                       | 26(16)                          | 88(18)                  | .552     | NA                    | NA      |
| Headache or dizzy            | 26(16)                          | 79(16)                  | .951     | NA                    | NA      |
| Myalgias                     | 26(16)                          | 104(21)                 | .142     | NA                    | NA      |
| Fatigue                      | 88(53)                          | 253(51)                 | .622     | NA                    | NA      |
| Symptom                        | Cancer COVID-19 Cohort | COVID-19 Cohort | p-value | p-value adjustment | p-value adjustment |
|-------------------------------|------------------------|-----------------|---------|-------------------|-------------------|
| Rhinorrhea                    | 10(6)                  | 20(4)           | .281    | NA                | NA                |
| Sore throat                   | 12(7)                  | 69(14)          | .024    | NA                | NA                |
| Dry cough                     | 72(43)                 | 264(53)         | .031    | NA                | NA                |
| Expectoration                 | 60(36)                 | 105(21)         | <.001   | NA                | NA                |
| Hemoptysis                    | 10(6)                  | 7(1)            | .003    | NA                | NA                |
| Chest congestion              | 70(42)                 | 203(41)         | .75     | NA                | NA                |
| Dyspnea                       | 40(24)                 | 79(16)          | .017    | NA                | NA                |
| Nausea or vomiting            | 21(13)                 | 45(9)           | .178    | NA                | NA                |
| Abdominal pain                | 8(5)                   | 15(3)           | .27     | NA                | NA                |
| Diarrhea                      | 31(19)                 | 101(20)         | .653    | NA                | NA                |
| Consciousness disorder        | 18(11)                 | 20(4)           | .001    | NA                | NA                |
| Complications                 |                        |                 |         |                   |                   |
| Respiratory failure           | 27(16)                 | 52(10)          | .045    | NA                | NA                |
| Acute cardiac injury          | 3(2)                   | 2(0)            | .195    | NA                | NA                |
| Acute kidney injury           | 29(18)                 | 41(8)           | .001    | NA                | NA                |
| Acute liver injury            | 53(32)                 | 110(22)         | .011    | NA                | NA                |
| Prothrombotic coagulopathy    | 2(1)                   | 4(1)            | 1.000   | NA                | NA                |
| Electrolytic disturbance      | 28(17)                 | 63(13)          | .171    | NA                | NA                |
| In-hospital infection         | 6(4)                   | 16(3)           | .802    | NA                | NA                |
| Treatment                     |                        |                 |         |                   |                   |
| Antiviral drug                | 108(65)                | 359(72)         | .086    | NA                | NA                |
| Intravenous antibiotics       | 88(53)                 | 224(45)         | .073    | NA                | NA                |
| Intravenous antifungal        | 20(12)                 | 36(7)           | .053    | NA                | NA                |
| Anticoagulation               | 50(30)                 | 37(7)           | <.001   | NA                | NA                |
| Intravenous corticosteroids   | 44(27)                 | 70(14)          | <.001   | NA                | NA                |

a Cancer COVID-19 Cohort vs COVID-19 Cohort
b Cancer COVID-19 Cohort vs Cancer Cohort
| Primary tumor subtype            | Patients, No. (%) |                  |                  |                  |                  |
|---------------------------------|-------------------|------------------|------------------|------------------|------------------|
|                                 | Total (n=166)     | Hospital mortality | 1-year mortality |                  |                  |
|                                 |                   | Dead (n=34)      | Alive (n=132)   | Dead (n=49)      | Alive (n=117)    |
| Total                           | 166(100)          | 34(20)           | 132(80)         | 49(30)           | 117(70)          |
| Solid tumors                    | 149(90)           | 26(17)           | 124(83)         | 38(26)           | 111(74)          |
| Thyroid and Breast              | 33(20)            | 2(6)             | 33(84)          | 2(6)             | 33(84)           |
| Thyroid                         | 14(8)             | 0                | 14(100)         | 0                | 14(100)          |
| Breast                          | 19(11)            | 2(11)            | 17(89)          | 2(11)            | 17(89)           |
| Female Genital                  | 16(9)             | 1(6)             | 15(94)          | 2(13)            | 14(87)           |
| Cervical                        | 9(5)              | 1(11)            | 8(89)           | 1(11)            | 8(89)            |
| Ovary                           | 4(2)              | 0                | 4(100)          | 1(25)            | 3(75)            |
| Endometrial                     | 3(2)              | 0                | 3(100)          | 0                | 3(100)           |
| Genitourinary                   | 22(13)            | 3(14)            | 19(86)          | 3(14)            | 19(86)           |
| Prostatic                       | 7(4)              | 2(29)            | 5(71)           | 2(29)            | 5(71)            |
| Bladder                         | 7(4)              | 0                | 7(100)          | 0                | 7(100)           |
| Renal                           | 5(3)              | 1(20)            | 4(80)           | 1(20)            | 4(80)            |
| Penile                          | 2(1)              | 0                | 2(100)          | 0                | 2(100)           |
| Testicular                      | 1(1)              | 0                | 1(100)          | 0                | 1(100)           |
| Lung                            | 25(15)            | 4(16)            | 21(84)          | 8(32)            | 17(68)           |
| Digestive System                | 42(25)            | 12(29)           | 30(71)          | 18(43)           | 24(57)           |
| Colon                           | 18(11)            | 3(17)            | 15(83)          | 7(39)            | 11(61)           |
| Gastric                         | 10(6)             | 5(50)            | 5(50)           | 5(50)            | 5(50)            |
| Liver                           | 6(4)              | 1(17)            | 5(83)           | 2(33)            | 4(67)            |
| Rectal                          | 5(3)              | 2(40)            | 3(60)           | 2(40)            | 3(60)            |
| Pancreas                        | 3(2)              | 1(33)            | 2(67)           | 2(67)            | 1(33)            |
| Other Solid                     | 11(7)             | 4(36)            | 7(64)           | 5(45)            | 6(55)            |
| Bone                            | 4(2)              | 0                | 4(100)          | 1(25)            | 3(75)            |
| Condition                        | Count 1 | Count 2 | Count 3 | Count 4 | Count 5 |
|---------------------------------|---------|---------|---------|---------|---------|
| Nasopharyngeal                  | 4(2)    | 2(50)   | 2(50)   | 2(50)   | 2(50)   |
| Brain                           | 2(1)    | 1(50)   | 1(50)   | 1(50)   | 1(50)   |
| Skin                            | 1(1)    | 1(100)  | 0       | 1(100)  | 0       |
| Hematologic malignancies        | 17(10)  | 8(47)   | 9(53)   | 11(65)  | 7(41)   |
| Lymphoid malignancy             | 14(8)   | 7(50)   | 7(50)   | 8(57)   | 6(43)   |
| Multiple myeloma                | 6(4)    | 4(67)   | 2(33)   | 5(83)   | 1(17)   |
| Non-Hodgkin lymphoma            | 4(2)    | 1(25)   | 3(75)   | 2(50)   | 2(50)   |
| Chronic lymphoblastic leukemia  | 2(1)    | 0       | 2(100)  | 0       | 2(100)  |
| Acute lymphoblastic leukemia    | 2(1)    | 2(100)  | 0       | 2(100)  | 0       |
| Myeloid malignancy              | 3(2)    | 1(33)   | 2(67)   | 2(67)   | 1(33)   |
| Acute myelogenous leukemia      | 2(1)    | 1(50)   | 1(50)   | 2(100)  | 0       |
| Myelodysplastic syndrome        | 1(1)    | 0       | 1(100)  | 0       | 1(100)  |
| Table 3 Outcomes of Cancer COVID-19 Cohort, COVID-19 Cohort, and Cancer Cohort |
|---------------------------------|---------------------------------|--------|----------------|--------|
|                                 | Patients, No. (%)               | Cancer COVID-19 Cohort (n=166) | COVID-19 Cohort (n=498) | P Value | Cancer Cohort (n=498) | P Value |
| COVID-19 severity               |                                 |                                 |                     |        |
| Non-severe                      | 106(64)                         | 399(80)                         | <.001               | NA     | NA                   |
| Severe                          | 60(36)                          | 99(20)                          | NA                  | NA     | NA                   |
| Oxygenation and Ventilation     |                                 |                                 |                     |        |
| Not requiring supplement oxygen | 47(29)                          | 170(34)                         | <.001               | NA     | NA                   |
| Requiring supplement oxygen     | 93(56)                          | 279(56)                         | NA                  | NA     | NA                   |
| HFNC                            | 2(1)                            | 23(5)                           | NA                  | NA     | NA                   |
| NIV                             | 11(7)                           | 8(2)                            | NA                  | NA     | NA                   |
| IMV or ECMO                      | 12(7)                           | 18(4)                           | NA                  | NA     | NA                   |
| Length of hospital stay, median (IQR), d | 25(15-33) | 21(11-28) | .005 | 8(3-14) | <.001 |
| Time from symptom onset to admission, median (IQR), d | 10(7-16) | 10(5-15) | .047 | NA | NA |
| Time from admission to follow-up, median (IQR), m | 12.2(12.1-12.6) | 12.2(12.1-12.6) | <.001 | 12.1(11.7-12.4) | .002 |
| Time from discharge to follow-up, median (IQR), m | 11.2(10.8-11.6) | 11.4(11.2-11.8) | <.001 | 11.2(10.7-11.7) | .822 |
| Mortality                       |                                 |                                 |                     |        |
| 1-year all-cause mortality      | 49(30)                          | 44(9)                           | <.001               | 80(16) | <.001                |
| 12-month post-discharge mortality| 15(11)                          | 2(0.4)                          | <.001               | 73(15) | .084                 |
| Hospital mortality              | 34(20)                          | 42(8)                           | <.001               | 8(2)   | <.001                |
| Consequences at 1-year followed up |                                 |                                 |                     |        |
| Number of patients              | 114                             | 432                             | NA                  | NA     | NA                   |
| Any one of symptoms             | 26(23)                          | 130(30)                         | 0.13                | NA     | NA                   |
| Fatigue                         | 5(4)                            | 53(12)                          | 0.016               | NA     | NA                   |
| Chest congestion                | 3(3)                            | 38(9)                           | 0.027               | NA     | NA                   |
| Condition          | Cancer COVID-19 Cohort | COVID-19 Cohort | p-value | Difference | Cohort | Cancer COVID-19 Cohort vs COVID-19 Cohort |
|--------------------|------------------------|----------------|---------|------------|--------|------------------------------------------|
| Cough              | 10(9)                  | 25(6)          | 0.24    | NA         | NA     | a Cancer COVID-19 Cohort vs COVID-19 Cohort |
| Expectoration      | 4(4)                   | 7(2)           | 0.2     | NA         | NA     | a Cancer COVID-19 Cohort vs COVID-19 Cohort |
| Dyspnea            | 9(8)                   | 27(6)          | 0.51    | NA         | NA     | a Cancer COVID-19 Cohort vs COVID-19 Cohort |
| Palpitations       | 2(2)                   | 9(2)           | 0.83    | NA         | NA     | a Cancer COVID-19 Cohort vs COVID-19 Cohort |
| Waist pain         | 7(6)                   | 20(5)          | 0.5     | NA         | NA     | a Cancer COVID-19 Cohort vs Cancer Cohort |
| Anxiety            | 0                      | 23(5)          | 0.021   | NA         | NA     | c as these patients were not necessarily hospitalized, their hospital mortality rate was calculated as when one deceased within the hospitalization time duration of their Cancer COVID-19 Cohort match patient. |
| Sleep difficulties | 1(1)                   | 5(1)           | 0.65    | NA         | NA     | a Cancer COVID-19 Cohort vs COVID-19 Cohort |

Abbreviations: HFNC, high-flow nasal canula for oxygen therapy; NIV, Noninvasive mechanical ventilation; IMV, Invasive mechanical ventilation; ECMO, Extracorporeal membrane oxygenation

a Cancer COVID-19 Cohort vs COVID-19 Cohort
b Cancer COVID-19 Cohort vs Cancer Cohort
c as these patients were not necessarily hospitalized, their hospital mortality rate was calculated as when one deceased within the hospitalization time duration of their Cancer COVID-19 Cohort match patient.

Figures
Figure 1

Kaplan-Meier Analysis Mortality of Cancer COVID-19 Cohort, COVID-19 Cohort and Cancer Cohort. A. Kaplan-Meier Analysis of Cancer COVID-19 Cohort, COVID-19 Cohort and Cancer Cohort in 1-year All-cause Post Admission Mortality; B. Kaplan-Meier Analysis of Cancer COVID-19 Cohort, COVID-19 Cohort and Cancer Cohort in 12-month All-cause Post-discharge Mortality.
Figure 2

Kaplan-Meier Analysis Mortality of Primary Tumor Subtype among Cancer COVID-19 Cohort. A. Kaplan-Meier Analysis of Primary Tumor Subtype among Cancer COVID-19 Cohort, Compared with the COVID-19 Cohort, patients with hematologic, brain, nasopharyngeal, digestive system, lung malignancies showed a significantly high risk of 1-year post admission mortality, whose risk stratification was defined as high risk group; while patients with breast and endocrine, genitourinary and female genital tumors showed moderate risk of 12-month post admission mortality showing no statistical difference from the COVID-19 Cohort, whose risk stratification was defined as moderate risk group. B. Kaplan-Meier Analysis of high and moderate risk stratification of Primary Tumor Subtype among Cancer COVID-19 Cohort in 1-year All-cause Post Admission Mortality; C. Kaplan-Meier Analysis of high and moderate risk stratification of Primary Tumor Subtype among Cancer COVID-19 Cohort in 12-month All-cause Post-discharge Mortality.
**Figure 3**

Multivariable Cox Regression Model Among Cancer COVID-19 Cohort for 1-year All-cause Mortality.

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