Reopening the "CANCER MOONSHOT" in the United States: A great task in the COVID-19 era

Chunsong Hu[1]

[1]Nanchang University

March 10, 2023

Abstract

Cancer is currently a leading cause of mortality in the globe, particularly in the COVID-19 era, due to not enough and not in time care and treatment as well as limited coverage of COVID-19 vaccination. This article briefly discusses the reopening of the "CANCER MOONSHOT" in the United States (US). It's time for conduction of novel strategies such as the iRT-ABCDEFG and web-based programs for prevention and management of cancer, and further deepen cooperation between China and the US so as to combat cancer and save more lives. In conclusion, as a huge biomedical engineering, the reopening of "CANCER MOONSHOT" is a great task with a special significance and value in the field of cancer prevention and treatment in the COVID-19 era.

REVIEW

Reopening the "CANCER MOONSHOT" in the United States: A great task in the COVID-19 era

Running title: COVID-19 & CANCER MOONSHOT

Chunsong Hu

Nanchang University, Hospital of Nanchang University, Jiangxi Academy of Medical Science, Nanchang 330006, Jiangxi, China

From: Nanchang University, Hospital of Nanchang University, Jiangxi Academy of Medical Science, No. 461 Bayi Ave, Nanchang 330006, Jiangxi, China. Tel: (+86) 189 70816800; Email: cnhucs@ncu.edu.cn or cnhucs@163.com

Word count: 2,112 (Main text) + 122 (Abstract)

References: 85

Table: 0

Figure: 1 Total pages: 18

Corresponding Author: Chunsong Hu, M.D., Ph.D., Associate Professor of Medicine, Department of Cardiovascular Medicine, Nanchang University, Hospital of Nanchang University, Jiangxi Academy of Medical Science, No. 461 Bayi Ave, Nanchang 330006, Jiangxi, China. Tel: (+86) 189 70816800; Email: cnhucs@ncu.edu.cn or cnhucs@163.com

Abstract

Cancer is currently a leading cause of mortality in the globe, particularly in the COVID-19 era, due to not enough and not in time care and treatment as well as limited coverage of COVID-19 vaccination. This article briefly discusses the reopening of the "CANCER MOONSHOT" in the United States (US). It's time

for conduction of novel strategies such as the iRT-ABCDEFG and web-based programs for prevention and management of cancer, and further deepen cooperation between China and the US so as to combat cancer and save more lives. In conclusion, as a huge biomedical engineering, the reopening of "CANCER MOONSHOT" is a great task with a special significance and value in the field of cancer prevention and treatment in the COVID-19 era.

Keywords: cancer, COVID-19, lifestyle, prevention, treatment

A great plan—reopening the "CANCER MOONSHOT" has been announced in the United States (US) by President JOE BIDEN in this February, which was ever launched by the Former President BARACK OBAMA in 2016[1-3]. It's really a good and meaningful decision since there is a giant challenge of major non-communicable diseases (mNCDs) in the globe[4], particularly cancer[5,6]. As we all known, cancer is a common disease that cause a heavy public health burden and is the leading cause of death. However, there are obvious cancer disparities in the US[7]. In China, there is "Healthy China 2030 Plan". Thus, we should control and prevent cancer with solid and effective strategies so as to save more lives.

Cancer care and treatment in the Covid-19 era

Currently, the Covid-19 pandemic is still continuing in the globe due to the Delta and Omicron variants of SARS-CoV-2. So far (May 6, 2022), there were more than 513.955 million confirmed cases and over 6.24 million deaths in countries worldwide according to the reports of the World Health Organization. Since cancer cases are an independent and high risk for SARS-CoV-2 infection and adverse outcomes of Covid-19, particularly with several risk factors, such as advancing age, smoking history, and concurrent comorbidities, better cancer management is needed and palliative care should be the prioritization during the pandemic[8,9], and it's also a chance to remodel cancer care in the globe[10].

On the one hand, the Covid-19 pandemic leads to an increased risk of fatal outcomes and higher mortality, and lowering quality of treatment, care, and life in patients with cancer[11], and assessment of the quality of the samples and associated data in Biobanks is also a novel challenge for cancer research[12]. On the other hand, treatment of Covid-19 in cancer cases is a big challenge because we need not only to protect cardiovascular system by vaccination and bio-agents during antiviral and anti-thrombus treatments, but also enhance survival rates of cancer and improve cancer outcomes. However, it remains uncertain regarding Covid-19 vaccine efficacy in cancer patients even if there are positive humoral and cellular immune responses[13]. Moreover, there are the risks of vaccine-related adverse events. Herein, the reopening of "CANCER MOONSHOT" during the pandemic and post-Covid-19 era is a fantastic decision with a special significance and value. It will help us to realize the transformation from cancer oppression to conquer cancer (Figure 1).

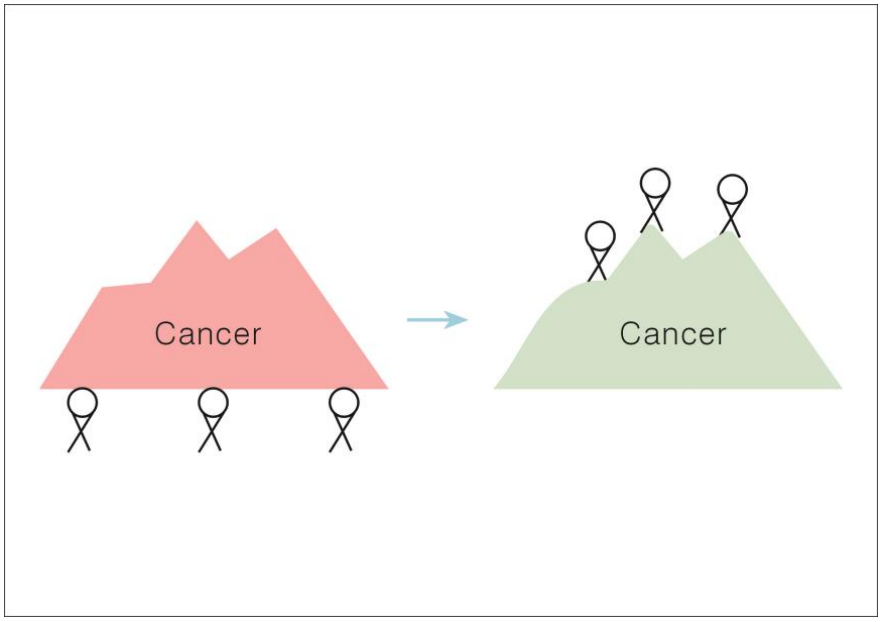

Fig. 1 | **The reopening of "CANCER MOONSHOT": From cancer oppression to conquer cancer** . It's believed that with the help of iRT-ABCDEFG program which includes the Goal of combating cancer in the globe, people will get the final victory by development of fresh preventive strategies, new diagnostic tools, and novel therapies of precise medicine.

During the pandemic or post-Covid-19 era, patients with active cancer and in cancer survivors have a worse outcome due to persistent multi-organ viral attacks or an abnormal immune response[14]. There are both more adverse cardiac outcomes and significantly increased cardiac biomarkers as well as a high in-hospital mortality in Covid-19 patients with cancer[15] due to mainly driven by gender, advancing age, smoking, socioeconomic deprivation, and other comorbidities[16,17], such as cardiovascular disease (CVD), diabetes. And these risk factors are more strongly associated with infection death. Covid-19 cases with both cancer and established CVD and risk factors are at the highest risk for serious complications, including death, thus, these patients need to be screened by both cardiac biomarkers and a more focused cardiovascular imaging approach so as to minimize the risk of SARS-CoV-2 infection[18]. In fact, Covid-19 is a vital risk factor for acute myocardial infarction and ischaemic stroke in the era of Covid-19[19].

Normalized understanding, lung cancer is still the leading cause of cancer death in the US (approximately 350 deaths per day)[6], however, breast cancer surpassed lung cancer as the leading cause of cancer death among Black women in 2019[20], and the number of cancer survivors continues to increase mainly due to improvement and advances in early screening, detection, and targeted treatment[6,21]. During the pandemic and post-Covid-19 era, there are rising needs for the rapid expansion of telemedicine platforms[14] for cancer cases. In a word, patients with cancer need the best possible care during the COVID-19 pandemic.

A study showed that endotheliopathy presented in Covid-19 is associated with critical illness and death[22]. Single-cell atlases revealed the biological effect of severe SARS-CoV-2 infection and new cellular targets for treatments[23]. Genome-wide CRISPR Screens also show potential therapeutic targets and small-molecule antagonists may inhibit SARS-CoV-2 infection[24]. These studies on the mechanisms and novel treatments will help to combat Covid-19 for improvement of cancer outcomes. And these new strategies will help to further improve quality of life (QOL) and outcomes in cancer patients with Covid-19 in the globe.

Vaccination of COVID-19 for protection of cancer cases

Since Covid-19 can be particularly lethal in patients with cancer[25] and vaccination may maximize the health

benefits[26], it' should be recommended to protect cancer patients. Clinical trials have demonstrated the safety and efficacy of specific chemicals, such as Remdesivir[27], and Tocilizumab, an IL-6 receptor (IL-6R) antagonist[28], multiple vaccines, such as Ad26.COV2.S[29,30], the mRNA-1273[31,32], and neutralizing antibodies, such as REGEN-COV[33], Sotrovimab[34], and Bamlanivimab[35] for the prevention and treatment of Covid-19. Definitely, these protective strategies should be prioritized for cancer patients during the Covid-19 pandemic.

However, there are increased risks of adverse outcomes or events (myocarditis, pericarditis, and cardiac arrhythmias) following vaccination of messenger RNA-based (mRNA) vaccines (BNT162b2 and mRNA-1273) in the general population, particularly those younger than 40[36]. Moreover, there is also cytokine release syndrome (CRS), a vaccine-related adverse event, evidenced by raised inflammatory markers, thrombocytopenia, elevated cytokine levels (IFN-γ/IL-2R/IL-18/IL-16/IL-10) and steroid responsiveness[37]. But there is also a study which found that a third dose of BNT162b2 (mRNA vaccine of COVID-19) is safe, improves humoral immunity against SARS-CoV-2 and could be immunologically beneficial for patients with cancer (solid tumors) on active chemotherapy[38].

Although patients with Covid-19 have high risk of adverse outcomes during active cancer care and treatment[39,40], e.g., deep vein thrombosis, pulmonary embolism, and bleeding[41], cancer patients have lower rates of SARS-CoV-2 infection after Covid-19 vaccination, especially with additional vaccination doses (e.g., mRNA-1273)[42,43]. On the one hand, treatment of solid cancer needs to follow standardized guidelines[44], and the use of a third vaccine dose can improve outcomes[45]. On the other hand, those advanced age, male, with a hematologic malignant tumor, had low antibody titers after vaccination[46], moreover, 50% of patients with hematologic cancers and solid cancers, have lost nAbs against major variants at 6 months after vaccination[47]. After the third dose of vaccination, patients with cancer have improved antibody levels[48], even a 20-fold increase in titers from a third dose[46]. Currently, mortality in cancer patients confirmed with Covid-19 has also improved in Europe[49]due to earlier diagnosis and improved management. In general, the mRNA-1273 COVID-19 vaccine is safe and beneficial for patients with cancer[50,51], particular in preventing serious illness and death due to the potential for immune activation[52].

Novel strategies for management of cancer in the COVID-19 era

Novel strategies are needed to change current side-effects of the COVID-19 pandemic on biomedical and cancer research practices as well as health care[53,54], for example, a mounting mental health crisis[55]. And scientists and clinicians should know about the importance of public engagement with science[56]. Currently, a detailed plan should be prepared for cancer care and treatment during Covid-19[57]. For example, as simple public measures, wearing cloth masks and keeping social isolation are needed for against the risk for a potential Covid-19 exposure and prevention of Covid-19[58,59]. However, there were more common of cancelled medical care and cancer screening during Covid-19[60]. Thus, we should have appropriate allocation of limited health care resources.[25] Current short-term follow-up showed that a considerable prevalence of neurocognitive impairment, psychiatric morbidity and poor QOL in Covid-19 survivors[61], but there are no data on whether these patients will suffer from cancer in the future.

Proudly, a general formula for management of mNCDs or a healthy and longevity equivalence and a standardized comprehensive iRT-ABCDEF program for cancer had already been setup[62,63]. Since major risk factors related to unhealthy lifestyle highly link to cancer and other mNCDs (CVD, diabetes, chronic respiratory or renal disease, neurodegenerative or mental disease), healthy "environment-sleep-emotion-exercise-diet" intervention [E(e)SEEDi] lifestyle is very helpful to human health. As a novel and magic "polypills"[64], it's worthy of conduction for universal health coverage. For example, as a healthy lifestyle, the olive oil consumption is beneficial to human health, and particularly for the prevention of mNCDs (CVD, diabetes, and cancer) and inflammation including SARS-CoV-2 infection[65], and higher olive oil intake was associated with lower risk of total and cause-specific mortality[66]. Newly, the scientists in the US developed a noninvasive treatment platform for diverse cancer types[67], it's helpful to many patients.

There are similarities in risk for both COVID-19 and cancer disparities due to socioeconomic disadvantages, level of education, lifestyle factors, health comorbidities, and limited access to medical care[68]. And there are

low anxiety and deteriorating mental health among patients with cancer during the COVID-19 pandemic[69]. On the one hand, delays in surgery may result in extensive psychosocial distress[70]. On the other hand, the proportion over-due for cancer screening is increasing[71]. Thus, innovative early detection and diagnosis, and timely and appropriate therapy for cancer are vital measures for the secondary prevention of cancer in the COVID-19 pandemic[72].

It's also important steps by the prioritization of oncological surgical care and the allocation of resources during the COVID-19 pandemic[73]. In addition, lifestyle modification (dietary supplementation and regular physical exercise) is effective in treatment outcomes, quality of life, and overall survival in cancer patients with COVID-19[74]. Moreover, clinical decision support systems[75] and web-based lifestyle interventions[76,77] for cancer survivors are a promising treatment option due to being both affordable and accessible. Despite challenges due to the COVID-19 pandemic, the home-based vegetable gardening program is feasible, well-received, and may result in increased V and F consumption among cancer survivors[78].

Cooperation between China and the US for combating cancer

At present, Chinese people are working hard to build a healthy, prosperous, beautiful, harmonious "HAPPINESS CHINA". I think that "common health is common prosperity" in the new era. In fact, "common prosperity" includes the organic unity of "material wealth, spiritual wealth, and physical and mental health". It can be said that "common health" is a higher level of "common prosperity". This is not only the common ideal and pursuit of Chinese people, but also the people of the world, including the US. The new vision of "A Community with A Shared Future for Mankind" proposed by Chinese President XI JINPING in Switzerland 5 years ago[79] has been widely recognized by the international community. This requires us to first strive to improve and protect the ecosystem, control and reduce environmental pollution.

Sincerely speaking, China is currently committed to carbon neutralization and carbon peaking for better protection of the ecosystem. And China and the US reached friendly cooperation in the field of the global climate change, which is also an important opportunity. Both sides should take this as the fulcrum to expand and deepen relevant cooperation. Whatever, I think these strategies are also very helpful to new "CANCER MOONSHOT" in the US. I sincerely expect the cooperation between China and the US is beneficial to the world's economic and social development.

All in all, the Covid-19 pandemic is still continuing in the globe due to the Delta and Omicron variants of SARS-CoV-2. Since there were higher viral loads in patients infected with the SARS-CoV-2 variants[80], and early non-neutralizing, afucosylated antibody responses are associated with Covid-19 severity[81], whether these patients are easy to suffer from cancer after recovery or not, and whether cancer patients with Covid-19 are easy to have adverse outcomes or recover, it needs longer-term follow-up or more data. And I think that the reopening of "CANCER MOONSHOT" in the US is really a great task with a special significance and value in both the pandemic and post-Covid-19 era. At the same time, since the distance between cancer and health is only "1M"[82], and there are cardiovascular, diabetes, and cancer strips[83], both "*Health in All Policies* " and "*Health in All Laws* "[63,84,85]are helpful to cancer prevention and treatment in the globe.

Conclusions and outlook

Cancer is currently a leading cause of mortality in the globe, particularly in the COVID-19 era, due to not enough and not in time care and treatment as well as limited coverage of COVID-19 vaccination. It's time for conduction of a novel program for prevention and management of cancer and further deepen cooperation between China and the US so as to combat cancer. In conclusion, the reopening of "CANCER MOONSHOT" is a great task with a special significance and value in the field of cancer prevention and treatment in the COVID-19 era.

References

1. Kaiser J, Couzin-Frankel J. BIOMEDICAL RESEARCH. Biden seeks clear course for his cancer moonshot. Science 2016;351:325-6.

2. Singer DS, Jacks T, Jaffee E. A U.S. "Cancer Moonshot" to accelerate cancer research. Science 2016;353:1105-6.

3. Yaffe MB, VanHook AM. *Science Signaling* Podcast for 14 March 2017: The Cancer Moonshot. Sci Signal 2017;10:eaan1418.

4. Hu CS, Tkebuchava T. SEEDi$^{1.0\text{-}3.0}$ strategies for major noncommunicable diseases in

China. J Integr Med 2017;15:265-9.

5. Chen W, et al. Cancer statistics in China, 2015. CA Cancer J Clin 2016;66:115-32.

6. Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2022. CA Cancer J Clin 2022;72:7-33.

7. Islami F, et al. American Cancer Society's report on the status of cancer disparities in the United States, 2021. CA Cancer J Clin 2022;72:112-43.

8. Spicer J, Chamberlain C, Papa S. Provision of cancer care during the COVID-19 pandemic. Nat Rev Clin Oncol 2020;17:329-31.

9. Sengar M, et al. TMH COVID-19 action group. Outcomes of COVID-19 and risk factors in patients with cancer. Nat Cancer 2022; Apr 4.

10. van de Haar J, et al. Caring for patients with cancer in the COVID-19 era. Nat Med 2020;26(5):665-671.

11. van der Veldt AAM, et al. COVID-19 vaccination: the VOICE for patients with cancer. Nat Med 2021;27(4):568-569.

12. Hofman P, Puchois P, Brest P, Lahlou H, Simeon-Dubach D. Possible consequences of the COVID-19 pandemic on the use of biospecimens from cancer biobanks for research in academia and bioindustry. Nat Med 2020;26(6):809-810.

13. Fendler A, et al. COVID-19 vaccines in patients with cancer: immunogenicity, efficacy and safety. Nat Rev Clin Oncol 2022;..:1-17.

14. Bisceglia I, et al. Cardio-Oncology in the COVID Era (Co & Co): The Never Ending Story. Front Cardiovasc Med 2022;9:821193.

15. Huang Y, et al. Clinical characteristics, risk factors, and cardiac manifestations of cancer patients with COVID-19. J Appl Physiol (1985) 2021;131:966-76.

16. Lee LY, et al. UK Coronavirus Monitoring Project Team, Kerr R, Middleton G. COVID-19 mortality in patients with cancer on chemotherapy or other anticancer treatments: a prospective cohort study. Lancet 2020;395:1919-26.

17. Drozd M, et al. Non-communicable disease, sociodemographic factors, and risk of death from infection: a UK Biobank observational cohort study. Lancet Infect Dis 2021;21:1184-91.

18. Lenihan D, et al. Cardio-oncology care in the era of the coronavirus disease 2019 (COVID-19) pandemic: An International Cardio-Oncology Society (ICOS) statement. CA Cancer J Clin 2020;70:480-504.

19. Katsoularis I, Fonseca-Rodríguez O, Farrington P, Lindmark K, Fors Connolly AM. Risk of acute myocardial infarction and ischaemic stroke following COVID-19 in Sweden: a self-controlled case series and matched cohort study. Lancet 2021;398:599-607.

20. Giaquinto AN, Miller KD, Tossas KY, Winn RA, Jemal A, Siegel RL. Cancer statistics for African American/Black People 2022. CA Cancer J Clin 2022; 72(3):202-229.

21. Miller KD, et al. Cancer treatment and survivorship statistics, 2019. CA Cancer J Clin 2019;69:363-385.

22. Goshua G, et al. Endotheliopathy in COVID-19-associated coagulopathy: evidence from a single-centre, cross-sectional study. Lancet Haematol 2020;7:e575-82.

23. Delorey TM, et al. COVID-19 tissue atlases reveal SARS-CoV-2 pathology and cellular targets. Nature 2021;595:107-13.

24. Wei J, et al. Genome-wide CRISPR Screens Reveal Host Factors Critical for SARS-CoV-2 Infection. Cell 2021;184:76-91.e13.

25. Kutikov A, Weinberg DS, Edelman MJ, Horwitz EM, Uzzo RG, Fisher RI. A War on Two Fronts: Cancer Care in the Time of COVID-19. Ann Intern Med 2020;172:756-8.

26. Barnabas RV, Wald A. A Public Health COVID-19 Vaccination Strategy to Maximize the Health Gains for Every Single Vaccine Dose. Ann Intern Med 2021;174:552-3.

27. Gottlieb RL, et al. GS-US-540-9012 (PINETREE) Investigators. Early Remdesivir to Prevent Progression to Severe Covid-19 in Outpatients. N Engl J Med 2022;386:305-15.

28. Patel K, et al. Use of the IL-6R antagonist tocilizumab in hospitalized COVID-19 patients. J Intern Med 2021;289:430-3.

29. Sadoff J, et al. ENSEMBLE Study Group. Safety and Efficacy of Single-Dose Ad26.COV2.S Vaccine against Covid-19. N Engl J Med 2021;384:2187-201.

30. Sadoff J, et al. ENSEMBLE Study Group. Final Analysis of Efficacy and Safety of Single-Dose Ad26.COV2.S. N Engl J Med 2022;386:847-60.

31. Baden LR, et al. COVE Study Group. Efficacy and Safety of the mRNA-1273 SARS-CoV-2 Vaccine. N Engl J Med 2021;384:403-16.

32. El Sahly HM, et al. COVE Study Group. Efficacy of the mRNA-1273 SARS-CoV-2 Vaccine at Completion of Blinded Phase. N Engl J Med 2021;385:1774-85.

33. O'Brien MP, et al. Covid-19 Phase 3 Prevention Trial Team. Subcutaneous REGEN-COV Antibody Combination to Prevent Covid-19. N Engl J Med 2021;385:1184-95.

34. Gupta A, et al. COMET-ICE Investigators. Early Treatment for Covid-19 with SARS-CoV-2 Neutralizing Antibody Sotrovimab. N Engl J Med 2021;385:1941-50.

35. ACTIV-3/TICO Bamlanivimab Study Group, Lundgren JD, et al. Responses to a Neutralizing Monoclonal Antibody for Hospitalized Patients With COVID-19 According to Baseline Antibody and Antigen Levels : A Randomized Controlled Trial. Ann Intern Med 2022;175:234-43.

36. Patone M, et al. Risks of myocarditis, pericarditis, and cardiac arrhythmias associated with COVID-19 vaccination or SARS-CoV-2 infection. Nat Med 2022;28(2):410-422.

37. Au L, et al. Crick COVID-19 Consortium, Swanton C, Fribbens C, Wilkinson KA, Wilkinson RJ, Lau DK, Banerjee S, Starling N, Chau I; CAPTURE Consortium, Turajlic S. Cytokine release syndrome in a patient with colorectal cancer after vaccination with BNT162b2. Nat Med 2021;27(8):1362-1366.

38. Shroff RT, et al. A third dose of BNT162b2 (mRNA vaccine of COVID-19) is safe, improves humoral immunity against SARS-CoV-2 and could be immunologically beneficial for patients with cancer (solid tumors) on active chemotherapy. Immune responses to two and three doses of the BNT162b2 mRNA vaccine in adults with solid tumors. Nat Med 2021;27(11):2002-2011.

39. Chavez-MacGregor M, Lei X, Zhao H, Scheet P, Giordano SH. Evaluation of COVID-19 Mortality and Adverse Outcomes in US Patients With or Without Cancer. JAMA Oncol. 2022;8(1):69-78.

40. Wang W, Kaelber DC, Xu R, Berger NA. Breakthrough SARS-CoV-2 Infections, ospitalizations, and Mortality in Vaccinated Patients With Cancer in the US Between December 2020 and November 2021. JAMA Oncol. 2022; Apr 8.

doi: 10.1001/jamaoncol.2022.1096.

41. Katsoularis I, et al. Risks of deep vein thrombosis, pulmonary embolism, and bleeding after covid-19: nationwide self-controlled cases series and matched cohort study. BMJ. 2022;377:e069590.

42. Wu JT, et al. Association of COVID-19 Vaccination With SARS-CoV-2 Infection in Patients With Cancer: A US Nationwide Veterans Affairs Study. JAMA Oncol. 2022;8(2):281-286.

43. Giuliano AR, et al. Evaluation of Antibody Response to SARS-CoV-2 mRNA-1273 Vaccination in Patients With Cancer in Florida. JAMA Oncol. 2022:e220001.

44. Hawley JE, et al. COVID-19 and Cancer Consortium (CCC19). Assessment of Regional Variability in COVID-19 Outcomes Among Patients With Cancer in the United States. JAMA Netw Open. 2022;5(1):e2142046.

45. Fenioux C, et al. SARS-CoV-2 Antibody Response to 2 or 3 Doses of the BNT162b2 Vaccine in Patients Treated With Anticancer Agents. JAMA Oncol. 2022;8(4):612-617.

46. Khan QJ, et al. Evaluation of the Durability of the Immune Humoral Response to COVID-19 Vaccines in Patients With Cancer Undergoing Treatment or Who Received a Stem Cell Transplant. JAMA Oncol. 2022;

doi: 10.1001/jamaoncol.2022.0752.

47. Obeid M, et al. Humoral Responses Against Variants of Concern by COVID-19 mRNA Vaccines in Immunocompromised Patients. JAMA Oncol. 2022:e220446.

48. Mair MJ, et al. Third dose of SARS-CoV-2 vaccination in hemato-oncological patients and health care workers: immune responses and adverse events - a retrospective cohort study. Eur J Cancer. 2022;165:184-194.

49. OnCovid Study Group, Pinato DJ, et al. Time-Dependent COVID-19 Mortality in Patients With Cancer: An Updated Analysis of the OnCovid Registry. JAMA Oncol. 2022;8(1):114-122.

50. Scoccianti S, Delli Paoli C, Grilli Leonulli B, et al. Acute tolerance of Moderna mRNA-1273 vaccine against COVID-19 in patients with cancer treated with radiotherapy. Lancet Oncol. 2021;22(9):1212-1214.

51. Oosting SF, van der Veldt AAM, GeurtsvanKessel CH, et al. mRNA-1273 COVID-19 vaccination in patients receiving chemotherapy, immunotherapy, or chemoimmunotherapy for solid tumours: a prospective, multicentre, non-inferiority trial. Lancet Oncol. 2021;22(12):1681-1691.

52. Morris VK, Kopetz S. Don't blame the messenger: lessons learned for cancer mRNA vaccines during the COVID-19 pandemic. Nat Rev Cancer. 2022 Mar 11:1-2. doi: 10.1038/s41568-022-00463-4.

53. Levine RL, Rathmell WK. COVID-19 impact on early career investigators: a call for action. Nat Rev Cancer. 2020;20(7):357-358.

54. Mulholland EJ. Impact of COVID-19 on in vivo work and patient sample availability for cancer research. Nat Rev Cancer. 2021;21(3):139-140.

55. Creaton J. Addressing the mental health crisis. Nat Rev Cancer. 2021;21(1):1-2.

56. Balkwill FR. Cells are Us - combining research and public engagement. Nat Rev Cancer. 2021;21(5):277-278.

57. Pramesh CS, Badwe RA. Cancer Management in India during Covid-19. N Engl J Med 2020;382:e61.

58. Martinez JA, Miller RH, Martinez RA. Patient Questions Surrounding Mask Use for Prevention of COVID-19 and Physician Answers from an Evidence-Based Perspective: a Narrative Review. J Gen Intern Med 2021;36:2739-44.

59. Tung EL, De Marchis EH, Gottlieb LM, Lindau ST, Pantell MS. Patient Experiences with Screening and Assistance for Social Isolation in Primary Care Settings. J Gen Intern Med 2021;36:1951-7.

60. Wenger NS, Stanton AL, Baxter-King R, Sepucha K, Vavreck L, Naeim A. The Impact of COVID-19 on Routine Medical Care and Cancer Screening. J Gen Intern Med 2022; :1-7.

61. Méndez R, et al. Short-term neuropsychiatric outcomes and quality of life in COVID-19 survivors. J Intern Med 2021;290:621-31.

62. Hu CS, Tkebuchava T. New "P" in Medical Model. Chin Med J (Engl) 2016;129: 492-3.

63. Hu CS. Intervention of RT-ABCDEF for cancer. Croat Med J 2019;60:55-7.

64. Hu C. Grants supporting research in China. Eur Heart J 2018;39:2342-4.

65. Majumder D, et al. Olive Oil Consumption can Prevent Non-communicable Diseases and COVID-19: A Review. Curr Pharm Biotechnol 2022;23:261-75.

66. Guasch-Ferré M, et al. Consumption of Olive Oil and Risk of Total and Cause-Specific Mortality Among U.S. Adults. J Am Coll Cardiol 2022;79:101-12.

67. Kim G, et al. Ultrasound controlled mechanophore activation in hydrogels for cancer therapy. Proc Natl Acad Sci U S A 2022;119:e2109791119.

68. Newman LA, Winn RA, Carethers JM. Similarities in Risk for COVID-19 and Cancer Disparities. Clin Cancer Res. 2021;27(1):24-27.

69. Baffert KA, Darbas T, Lebrun-Ly V, et al. Quality of Life of Patients With Cancer During the COVID-19 Pandemic. In Vivo. 2021;35(1):663-670.

70. Forner D, Murnaghan S, Porter G, et al. Psychosocial Distress in Adult Patients Awaiting Cancer Surgery during the COVID-19 Pandemic. Curr Oncol. 2021;28(3):1867-1878.

71. Datta GD, Lauzon M, Salvy SJ, et al. Cancer Screening Practices Among Healthcare Workers During the COVID-19 Pandemic. Front Public Health. 2022;10:801805.

72. McCormack V, Aggarwal A. Early cancer diagnosis: reaching targets across whole populations amidst setbacks. Br J Cancer. 2021;124(7):1181-1182.

73. Perrone AM, Dondi G, Giunchi S, et al. COVID-19 free oncologic surgical hub: The experience of reallocation of a gynecologic oncology unit during pandemic outbreak. Gynecol Oncol. 2021;161(1):89-96.

74. Molanouri Shamsi M, Vahed A, Hekmatikar AA, Suzuki K. Combined Effects of Exercise Training and Nutritional Supplementation in Cancer Patients in the Context of the COVID-19: A Perspective Study. Front Nutr. 2022;9:847215.

75. Papandreou P, Gioxari A, Nimee F, Skouroliakou M. Application of Clinical Decision Support System to Assist Breast Cancer Patients with Lifestyle Modifications during the COVID-19 Pandemic: A Randomised Controlled Trial. Nutrients. 2021;13(6):2115.

76. Drijver AJ, Reijneveld JC, Wesselman LMP, Klein M. A Web-Based Lifestyle Intervention Aimed at Improving Cognition in Patients With Cancer Returning to Work in an Outpatient Setting: Protocol for a Randomized Controlled Trial. JMIR Res Protoc. 2021;10(4):e22670.

77. Pekmezi DW, Crane TE, Oster RA, et al. Rationale and Methods for a Randomized Controlled Trial of a Dyadic, Web-Based, Weight Loss Intervention among Cancer Survivors and Partners: The DUET Study. Nutrients. 2021;13(10):3472.

78. Blair CK, Adsul P, Guest DD, et al. Southwest Harvest for Health: An Adapted Mentored Vegetable Gardening Intervention for Cancer Survivors. Nutrients. 2021;13(7):2319.

79. http://paper.people.com.cn/rmrbhwb/html/2022-01/17/content_25898848.htm

80. Müller NF, et al. Viral genomes reveal patterns of the SARS-CoV-2 outbreak in Washington State. Sci Transl Med 2021;13:eabf0202.

81. Chakraborty S, et al. Early non-neutralizing, afucosylated antibody responses are associated with COVID-19 severity. Sci Transl Med 2022;14:eabm7853.

82. Hu CS, Wu QH, Hu DY. Cardiovascular, diabetes, and cancer strips: evidences, mechanisms, and classifications. J Thorac Dis. 2014;6(9):1319-1328.

83. Hu C, Tkebuchava T, Wu Q, Hu D. How Far is between Cancer and Health? Iran J Public Health. 2019;48(5):974-976.

84. Hu C, Wu Q. Health: a dream from reality to the future. Front Med. 2016;10(2):233-5.

85. Hu C, Tkebuchava T. Health in All Laws: A better strategy for global health. J Evid Based Med. 2022;15(1):10-14.

Acknowledgments

The reviewers and editors are gratefully acknowledged for critical review.

Author contributions

C.H. is an Associate Professor of Medicine, Hospital of Nanchang University, Jiangxi Academy of Medical Science, Nanchang University, Jiangxi, China. He had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Additional information

Correspondence should be addressed to Chunsong Hu

Competing interests

The author declares no competing interests.

Peer review information ...

Funding/Support: No funding for this study was received.