

COVID-19 CADTH HORIZON SCAN

COVID-19 mRNA Vaccines for People With Cancer

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Key Messages

- The first two vaccines (both messenger ribonucleic acid — mRNA — vaccines) for the prevention of COVID-19 disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) have been authorized for emergency use.
- People with cancer are at a higher risk for serious illness resulting from COVID-19.
- People with cancer were not specifically included in the clinical trials that assessed the mRNA vaccines for COVID-19; the safety and effectiveness of these vaccines for people with cancer remains uncertain.
- Some countries have included people with cancer as part of the groups who are being considered for priority access to COVID-19 vaccines, but further study and information-gathering is still required.

Background and Context

COVID-19 mRNA Vaccines

The first vaccine for the prevention of COVID-19 disease caused by the SARS-CoV-2 virus, produced by Pfizer-BioNTech, received authorization by interim order in Canada on December 9, 2020.¹ The second vaccine for the prevention of COVID-19, produced by Moderna, received Emergency Use Authorization (EUA) from the US FDA on December 18, 2020.² These vaccines are based on messenger ribonucleic acid (mRNA), as are a few others in development. Vaccines using mRNA contain a small piece of lab-made viral genetic code for the virus' spike protein.³ When the viral mRNA enters the human body, it is able to tell cells to produce the viral spike proteins and prepares the immune system to be able to recognize and destroy the virus without infecting the recipient with the actual virus.³

Factors such as immunosuppression associated with cancer treatments and the vulnerability of patients with cancer to negative COVID-19 outcomes have raised questions as to whether it is recommended or safe for this population to be prioritized for vaccination.³

Benefits and Harms of COVID-19 mRNA Vaccines for People With Cancer

As mRNA vaccines are enclosed in lipid envelopes, there is some concern that the lipids may accumulate in solid tumours.⁴ There is also the potential for solid tumours to absorb a significant part of the vaccine dose, thus reducing its effectiveness. The extent to which either of these situations might happen in actual practice is not currently known.⁴

Both the Pfizer-BioNTech and the Moderna vaccines use mRNA to produce an immune response and do not contain any live virus; they should not pose the same issues for people who are immunocompromised as do live vaccines such as the one for measles.⁵ There is reason to believe that the COVID-19 mRNA vaccines will produce an adequate immune response in people who have previously had successful cancer treatment and in those who have not received immunosuppressive treatment within a few months of vaccination, but further study is required to confirm these assumptions.⁶

The efficacy trials for the existing mRNA vaccines were designed to measure the reduction in symptomatic cases of COVID-19 among participants.⁵ They were not designed to detect asymptomatic cases of COVID-19; the vaccines' potential to prevent asymptomatic spread is still unknown.⁵ Determining whether the vaccines can prevent the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) will be an important outcome to study as more people receive doses of the new vaccines. The less virus there is in the community,

the less easily it will spread to those who have not yet received a vaccination or who are unable to receive one because of contraindications.⁵

Objectives

The objectives of this report are to:

- list ongoing clinical trials regarding COVID-19 mRNA vaccines for which patients with cancer or who are immunocompromized are eligible for inclusion
- identify national vaccine prioritization criteria that mention patients with cancer or those with compromised immune systems
- identify statements made by clinical or cancer societies and organizations regarding the safety, status, or prioritization of COVID-19 vaccinations for people with cancer.

Methods

A limited literature search was conducted by an information specialist on key resources including ClinicalTrials.gov and websites of major cancer organizations. A focused internet search was also conducted. The search was limited to information originating from Canada, the US, the UK, Europe, Australia, New Zealand, and major international organizations. The main search concepts were COVID-19, vaccination, and cancer. Where possible, retrieval was limited to the human population. The search was limited to English- or French-language literature. The search was conducted on December 16, 2020.

The focused internet search was supplemented by handsearching until December 21, 2020. Literature search results were screened by single reviewers. Relevant clinical trials were identified by reviewing those included in the existing CADTH report on vaccines for COVID-19⁷ and the results of the search of ClinicalTrials.gov. Relevant findings were summarized in tables and text.

Clinical Trials for COVID-19 mRNA Vaccines

Findings from the clinical trials regarding the safety and efficacy of the Pfizer-BioNTech and Moderna mRNA vaccines have been published in academic journals.⁸⁻¹² The Pfizer-BioNTech trials generally excluded people with cancer from participating; those who were healthy (or who had stable chronic conditions) were eligible for inclusion and those with immunosuppressive conditions or were receiving immunosuppressive therapy (including for cancer) were excluded.^{3,10,11,13,14} The Moderna trials also generally excluded people with cancer from participating, with the exception of those with non-melanoma skin cancer¹⁵ or basal cell and squamous cell carcinoma of the skin.¹⁶ Whether patients with these conditions were included in the data published to date for these trials is unknown.^{8,9}

There are several ongoing trials investigating the effectiveness and safety of vaccines for the prevention of COVID-19 (several of which are summarized in a CADTH report that is current up to August 10, 2020).⁷ Most trials of vaccines for the prevention of COVID-19 enrol healthy adults. To our knowledge, only three trials regarding COVID-19 mRNA vaccines explicitly mention the inclusion or exclusion of patients with cancer. Specifically, one ongoing phase III clinical trial for an additional mRNA vaccine candidate from CureVac AG was identified through ClinicalTrials.gov in December 2020.^{17,18} People with a current or past diagnosis of cancer (unless completely resolved without sequelae for more than five years)¹⁷ are specifically excluded from participating in this study. Additionally, anyone receiving treatment with immunosuppressants or other immune-modifying drugs for more

than 14 days total within the six months preceding the administration of the trial vaccine are excluded from participating.^{17,18} In the second ongoing trial on an mRNA vaccine by Arcturus Therapeutics, patients with malignancy within five years of vaccination are excluded with the exception of “basal or squamous cell carcinoma of the skin or carcinoma in situ of the cervix that has been successfully treated.”¹⁹ Lastly, in an ongoing trial at the Shulan (Hangzhou) Hospital in China, patients with a “history of malignant tumors” are excluded.^{20,21}

National Vaccine Prioritization Criteria

The UK, the US, France, and Australia have specifically included people with cancer in their prioritization schemes for the COVID-19 vaccines. The statements regarding prioritization are summarized in Table 1.

The US has developed guidance specific to the rollout of the Pfizer-BioNTech and Moderna vaccines.^{22,23} People with cancer are not specifically mentioned, but the guidance states that sufficient data are not currently available to establish the safety and efficacy for people with immunocompromizing conditions or who take immunosuppressive medications or therapies.²²⁻²⁴

Table 1: National Vaccine Prioritization Schemes That Specify People With Cancer

Jurisdiction	Date of last update	Statements on vaccine prioritization
UK ²⁵	December 14, 2020	<p>Phase I — direct prevention of mortality and supporting the NHS and social care system. This priority list is, as follows:</p> <ul style="list-style-type: none"> • residents in a care home for older adults and their carers • all those 80 years of age and older and front line health and social care workers • all those 75 years of age and older • all those 70 years of age and older, and clinically extremely vulnerable individuals • all those 65 years of age and older • all individuals aged 16 years to 64 years of age with underlying health conditions that put them at higher risk of serious disease and mortality • all those 60 years of age and older • all those 55 years of age and older • all those 50 years of age and older <p>The definition of “clinically extremely vulnerable” includes people with specific cancers (among other conditions):</p> <ul style="list-style-type: none"> • people with cancer who are undergoing active chemotherapy • people with lung cancer who are undergoing radical radiotherapy • people with cancers of the blood or bone marrow such as leukemia, lymphoma, or myeloma who are at any stage of treatment • people having immunotherapy or other continuing antibody treatments for cancer • people having other targeted cancer treatments that can affect the immune system, such as protein kinase inhibitors or PARP inhibitors • people who have had bone marrow or stem cell transplants in the last six months or who are still taking immunosuppression drugs
US ^{26,27}	December 13, 2020	<p>Before making an official recommendation, ACIP considered four groups to possibly recommend for early COVID-19 vaccination if supply is limited:</p>

		<ul style="list-style-type: none"> • health care personnel • workers in essential and critical industries • people at high risk for severe COVID-19 illness due to underlying medical conditions (including cancer) • people 65 years and older
US ²⁷⁻²⁹	December 11, 2020	<p>“Phase1c:</p> <ul style="list-style-type: none"> • Adults with high-risk medical conditions • Adults 65+”²⁹ <p>Cancer is listed as a condition that increases the risk of severe illness from the virus that causes COVID-19.²⁷</p>
Australia ³⁰	December 8, 2020	<p>Priority groups include: “People who have an increased risk, relative to others, of developing severe disease or dying from COVID-19:</p> <ul style="list-style-type: none"> • older people • people with certain pre-existing underlying medical conditions • Aboriginal and Torres Strait Islander people.”³⁰ <p>“High-risk” people include those who have blood cancers diagnosed within the last five years. People who have had a non-hematological cancer diagnosed within the last 12 months are determined to be at a “moderate risk.”</p>
France ^{31,32}	November 30, 2020	<p>Vaccine delivery will be divided into five phases, with the first three phases defined as critical. “High-risk co-morbidities” to be considered include active malignant cancers and hematological diseases less than three years old.</p> <p>Phase I:</p> <ul style="list-style-type: none"> • residents of elder care and long-term care facilities • professionals working in the aforementioned establishments who themselves are older than 65 years of age or who have comorbidities <p>Phase II:</p> <ul style="list-style-type: none"> • the elderly older than 75 years of age, beginning with older groups or those having one or more comorbidities • then, people aged 65 to 74 years, prioritizing those with one or more comorbidities • then, professionals in the health and medico-social sectors aged 50 and older or presenting with one or more comorbidities (regardless of the mode of practice) <p>Phase III:</p> <ul style="list-style-type: none"> • unvaccinated people who are at risk because of their age (50 to 65 years) or comorbidities • because of their age (50 to 65 years) or their previously unvaccinated comorbidities • professionals in the health and medico-social sectors not previously vaccinated • operators and professionals in essential sectors

ACIP = Advisory Committee on Immunization Practices; NHS = National Health Service; PARP = poly ADP ribose polymerase.

Prioritization lists from some other countries mention that people with “high-risk conditions” should be prioritized to receive COVID-19 vaccines; however, cancer is either not specifically mentioned in the definition of “high-risk” or no definition of this group was provided. The vaccine prioritization schemes for these countries, including Canada, are summarized in Table 2.

Table 2: National Vaccine Prioritization Schemes That Do Not Specify People With Cancer

Jurisdiction	Date of last update	Statements on vaccine prioritization
Canada ³³	November 2020	<p>“Key populations include:</p> <ul style="list-style-type: none"> • Those at high risk of severe illness and death from COVID-19 • Advanced age • Other high-risk conditions (to be defined as the evidence base evolves)”³³ <p>Note: Cancer is not currently specified on the list of high-risk conditions.</p>
Norway ³⁴	December 15, 2020	<p>Risk groups include:</p> <ul style="list-style-type: none"> • residents in nursing homes • people older than 65 years • people aged 18 to 64 who have one or more of the diseases that are known to give an increased risk of severe disease or death if they develop COVID-19 <p>Note: Cancer is not currently specified on the list of high-risk conditions.</p>
Ireland ³⁵	December 13, 2020	<p>The Irish National Immunisation Advisory Committee has created a provisional priority list of groups for vaccination.</p> <p>This is the provisional order in which people in Ireland will be vaccinated against COVID-19:</p> <ul style="list-style-type: none"> • people aged 65 years and older who are residents of long-term care facilities (likely to include all staff and residents on site) • front line health care workers • people aged 70 and older • other health care workers not in direct patient contact • people aged 65 to 69 (prioritize those with medical conditions that put them at high risk of severe disease) • key workers (to be further refined) • people aged 18 to 64 with certain medical conditions that put them at high risk of severe disease • residents of long-term care facilities aged 18 to 64 • people aged 18 to 64 living or working in crowded settings • key workers in essential jobs who cannot avoid a high risk of exposure • people working in the education sector • people aged 55 to 64 • other workers in occupations important to the functioning of society • other people aged 18 to 54 • people aged younger than 18 and pregnant women <p>Medical conditions that put people at high risk of severe disease include: chronic heart disease (including hypertension with cardiac involvement); chronic respiratory disease (including asthma requiring continuous or repeated use of systemic steroids or with previous exacerbations requiring hospital admission); type 1 and type 2 diabetes; chronic neurological disease; chronic kidney disease; body mass index greater than 40; immunosuppression due to disease or treatment; chronic liver disease.</p> <p>Note: Cancer is not currently specified on the list of high-risk conditions.</p>
Finland ³⁶	December 9, 2020	<p>“COVID-19 vaccines are offered on the basis of medical risk assessment. In the first phase, vaccines will be offered to these priority groups:</p>

		<ul style="list-style-type: none"> Healthcare and social welfare workers caring for COVID-19 patients and care home workers Older adults Persons at high risk for severe disease due to underlying health conditions."³⁶ <p>Note: Cancer is not currently specified.</p>
Sweden ^{37,38}	December 4, 2020	<p>"The Swedish Public Health Agency has recommended that people are vaccinated in the following order:</p> <ul style="list-style-type: none"> People who live in elderly care homes or receive at-home care, primarily those aged over 70 Healthcare and care workers who have close contact with vulnerable people Other adults who share a household with people receiving at-home care."³⁷ <p>Note: Cancer is not currently specified.</p>
New Zealand ³⁹	December 1, 2020	No current information on priority groups.
Netherlands ⁴⁰	November 19, 2020	<p>"This strategy implies that, initially, the following groups are eligible for vaccination:</p> <ul style="list-style-type: none"> clinically vulnerable groups: people who run an increased risk of severe morbidity and mortality, namely people over the age of 60 and people with serious heart or respiratory conditions, diabetes mellitus, chronic renal insufficiency, immune disorders, or people being treated with immunosuppressants leading to reduced resistance to respiratory infections, people with mental disabilities who live in institutions and residents of nursing homes; if these medical risk groups cannot themselves be vaccinated for medical reasons, informal carers and healthcare workers who risk infecting them; healthcare workers who are in direct contact with patients."⁴⁰ <p>Note: Cancer is not currently specified.</p>
WHO ⁴¹	November 13, 2020	<p>"The evidence on specific comorbidities and the increased risk of severe COVID-19 is increasing. What is already clear is that i) several comorbidities increase this risk; ii) the increase in risk varies between specific comorbidities, and thus equity concerns would arise if all comorbidities were to be given similar weight; iii) in many countries, if everyone with a comorbidity were to be prioritized in early vaccine supply scenarios, those eligible for vaccination would well-exceed supply; and iv) the list of relevant comorbidities will be location dependent.</p> <p>Based on these considerations, countries should use relevant local and regional data to identify the comorbidities associated with different levels of risk from COVID-19 (for example, significant versus moderate risk). One approach is to identify the additional risk associated with each comorbidity. Another approach is to prioritize individuals who have two or more relevant comorbidities. As evidence develops, further guidance from SAGE on comorbidities and risk associated with severe COVID-19 will be communicated. Moreover, the SAGE Working Group on COVID-19 Vaccines is currently developing further guidance on comorbidities that put individuals at significantly higher risk."⁴¹</p> <p>Note: Cancer is not currently specified.</p>

SAGE = Systematic Assessment of Geriatric drug use via Epidemiology.

Clinical or Cancer Societies and Organizations

Recommendations regarding COVID-19 vaccination for people with cancer have not been specified in all national vaccine prioritization schemes; however, some patient organizations and societies have made statements about the safety and status of the vaccine for people with cancer. A summary of these statements is provided in Table 3.

Table 3: COVID-19 Vaccine Statements From Clinical or Cancer Societies and Organizations

Organization	Jurisdiction	Date of last update	Statement regarding COVID-19 vaccines
American Society of Clinical Oncology ⁵	US	December 16, 2020	"Despite the lack of information on the safety of the COVID-19 vaccine in people with cancer, many vaccinations are recommended for people with cancer, including the pneumococcal pneumonia vaccine and the flu vaccine. Some vaccines are OK to receive during cancer treatment, when the immune system is weak, but some vaccines, such as live virus vaccines, should not be given during cancer treatment. The COVID-19 vaccine is not a live virus vaccine." ⁵
Association of American Cancer Institutes ⁴²	US	December 15, 2020	"Health care providers at AACI cancer centers care for a particularly vulnerable patient population: many patients with cancer are immunosuppressed, and most have serious co-morbidities that increase their risk of contracting COVID-19. Cancer patients also experience poor outcomes after infection with the virus. This vaccine—and others that may receive EUA from the FDA—represents a major step forward in protecting these patients from another devastating illness." ⁴²
Cancer Research UK ³	UK	December 15, 2020	<p>"At this early stage, there isn't a huge amount of information about how effective the different vaccines are specifically for people with cancer.</p> <p>Why may vaccines be less effective for some people with cancer? Cancer and its treatment can weaken the immune system, making it harder to fight infections like COVID-19. It can also affect the way someone's immune system responds to a vaccine – altering how effective it may be in preventing or reducing the severity of an infection like COVID-19.</p> <p>It should become clearer how the vaccine may work for people with cancer as full results from clinical trials begin to emerge."³</p>
Kidney Cancer Association ⁴³	US	December 14, 2020	<p>"Given the high community transmission of COVID-19 and the potential for severe cases and death, the benefits of the vaccine likely outweigh the risks.</p> <p>Patients with kidney cancer (especially those whose cancer has spread to other organs) will often be taking targeted treatments or immunotherapies. From our current knowledge, we do not think that these treatments will have any impact on those patients' reactions to this new COVID-19 vaccine. As long as a vaccine is being offered and is not otherwise contraindicated (see allergic reactions to the components above), patients with kidney cancer are still good candidates to receive the COVID-19 vaccine and protect themselves from developing this potentially severe and deadly infection."⁴³</p>

MD Anderson Cancer Center ⁴⁴	US	December 11, 2020	<p>"People with serious health conditions such as cancer, and people with weakened immune systems, were not included in many of the COVID-19 vaccine clinical trials.</p> <p>As the vaccine becomes more widely available, we'll learn more about the indications, benefits, and side effects in people with serious health conditions. Your care team will then be able to give you that information so you can make an informed choice about vaccination."⁴⁴</p>
Dana-Farber Cancer Institute ⁶	US	December 10, 2020	<p>"It is still unknown if cancer patients undergoing active treatment would benefit from a COVID-19 vaccine, but there is ongoing research to determine its safety and efficacy in this patient population.</p> <p>It is believed both cancer survivors, and those who have not received immunosuppressive therapy for more than several months, will be able to mount a successful immune response to the COVID-19 vaccine. However, more information is needed."⁶</p> <p>"It is generally recommended that cancer patients do not receive vaccines if they are currently undergoing chemotherapy, immunotherapy, or radiation therapy, except for the flu shot. Vaccines need an immune system response to work properly, and patients undergoing treatment may have a weakened immune system. Infections are also possible if those with weakened immune systems are administered a vaccine with a live virus."⁶</p>
Cancer Treatment Centers of America ⁴⁵	US	December 4, 2020	<p>"Many vaccines work by educating and stimulating the immune system to recognize and attack viruses and other potentially dangerous invaders. To be effective, however, some vaccines may need a healthy immune system capable of launching a robust attack against a virus.</p> <p>Cancer patients who've had a stem cell transplant or are on an active chemotherapy or radiation therapy treatment regimen may have compromised immune system that may make the vaccine less effective."⁴⁵</p> <p>"Early information, however, indicates that the three leading COVID-19 vaccines should be safe...Due to the nature of the vaccines, there should not be complications giving it to cancer patients"⁴⁵</p>
Southern Alberta Myeloma Patient Society ⁴⁶	Canada	December 4, 2020	<p>"Any vaccine is "a risk" for cancer patients on active treatment. The vaccine will take longer to take effect. Like the flu vaccine, this is not a live vaccine and should be safe. If you have reactions to the flu vaccine then you will most probably have a reaction to the COVID-19 vaccine. Keep in mind you will need the booster vaccine in 4 to 6 weeks after the first injection."⁴⁶</p>
American Society of Hematology ⁴⁷	US	November 30, 2020	<p>"Potential considerations for testing prior to administration of SARS-CoV-2 vaccine in an immunocompromised patient include: CBC with differential, peripheral blood B and T cell immunophenotype, quantitative immunoglobulins (IgG, IgM, IgA), tetanus and pneumococcal titers, to determine if a patient is likely to mount a protective immune response. The impact of these parameters on responses to SARS-CoV-2 vaccines is unknown."⁴⁷</p>

			"Given patients with chronic lymphocytic leukemia, lymphoma or myelodysplasia may be prone to other immune-mediated complications, there is some concern that generating anti-SARS-CoV-2 antibodies in these patients could lead to immune enhancement and a systemic inflammatory response akin to what is seen with multisystem inflammatory syndrome in children (MIS-C)." ⁴⁷
Lung Cancer Research Foundation ⁴⁸	US	November 23, 2020	"Many national experts are developing guidance for vaccine distribution, with the National Academies issuing a framework that would see healthcare workers, frontline workers and those in high-risk categories being eligible to be vaccinated first. Given that several studies have now reported high mortality rates in patients with lung cancer who contract COVID-19, it is widely expected that lung cancer patients would be among those first eligible to receive the vaccine in the early stages of rollout." ⁴⁸
Leukemia & Lymphoma Society ⁴⁹	US	[no date]	"While the news of the approval is encouraging, and the pace of progress gives us all reason to be optimistic, more research is needed to determine the safety and efficacy of this and other COVID-19 vaccines for cancer patients" ⁴⁹ "LLS urges that over the coming months, clinical trials continue to expand to include blood cancer patients of all ages – including pediatric patients – and those who are immunosuppressed due to treatment like chemotherapy." ⁴⁹
Prostate Cancer UK ⁵⁰	UK	[no date]	"The vaccine doesn't contain a live virus, so you can't catch COVID-19 from the vaccine and it is safe for men having treatment for prostate cancer, including chemotherapy. However, you should still talk to your medical team about whether to have the vaccine if you're having chemotherapy." ⁵⁰ "We don't yet know how well the vaccine works in people with a weak immune system, including men having chemotherapy to treat prostate cancer. This is because the vaccine hasn't been tested in people having chemotherapy or other medicines that weaken the immune system." ⁵⁰

AACI = Association of American Cancer Institutes; ASCO = American Society of Clinical Oncology; CBC = complete blood count; EUA = Emergency Use Authorization; LLS = Leukemia & Lymphoma Society; MIS-C = multisystem inflammatory syndrome in children; SARS-Cov-2 = severe acute respiratory syndrome.

The websites of the following groups were searched, but no relevant statements regarding mRNA vaccines for COVID-19 were identified as of December 16, 2020:

- American Society of Clinical Oncology
- Association of Cancer Physicians
- BC Cancer Agency
- Canadian Association of Medical Oncologists
- Canadian Cancer Research Alliance
- Canadian Partnership Against Cancer
- Cancer Care Ontario
- Cancer Council Australia
- CancerCare Manitoba

- CDC Advisory Committee on Immunization Practices
- Danish Society for Clinical Oncology
- European Commission
- European Hematology Association
- European Society for Medical Oncology
- Medical Oncology Group of Australia
- National Cancer Institute
- National Comprehensive Cancer Network
- Nova Scotia health Authority Cancer Care Program
- Saskatchewan Cancer Agency
- Swedish Society of Oncology
- US FDA.

Summary

Three ongoing clinical trials regarding COVID-19 mRNA vaccines that explicitly mention the eligibility of patients with cancer were identified. Of these, people with a current or past diagnosis of cancer are excluded,^{17,18} those with a history of malignant tumours are excluded,^{20,21} and those with malignancy within five years are excluded with the exception of a specific cancer type (i.e., “basal of squamous cell carcinoma of the skin or carcinoma in situ of the cervix that has been successfully treated”).¹⁹ Most ongoing clinical trials continue to enrol primarily healthy adults.

National prioritization criteria were identified for 11 countries and one from WHO, four of which specified people with cancer at varying levels in prioritization criteria (complete summary in Table 1). People with cancer are not specifically mentioned in the Canadian prioritization scheme, although “those at high risk of severe illness and death from COVID-19” and those with “other high-risk conditions (to be defined as the evidence base evolves)” are listed among the “key populations” to be vaccinated.³³

Clinical and cancer societies and organizations have begun to comment on the use of the available mRNA vaccines for COVID-19 for people with cancer (Table 3). None of the identified organizations advocated strongly that people with cancer must be prioritized for vaccination and most of the statements suggested that further research is required before it can be determined whether these vaccines will be safe and effective for people with cancer. Many other organizations have yet to make statements specific to COVID-19 vaccination for people with cancer. This is perhaps unsurprising because data regarding the safety and effectiveness of the mRNA vaccines for COVID-19 in this population are extremely limited.

Gaps in the available information remain in several areas, such as the effect of potential lipid accumulation in solid tumours with mRNA vaccine administration, whether solid tumours absorb substantial proportions of the vaccine and reduce its efficacy, and whether patients with cancer are able to mount a sufficient immune response upon receipt of the vaccine. Research in this area will continue to evolve as more people receive the vaccines.

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