TE AHO O TE KAHU CANCER CONTROL AGENCY

COVID-19 vaccination and cancer patients

Information for clinicians: last updated 27 October 2021

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Reason for update: updated advice on a third primary dose of Pfizer/BioNTech vaccine for severely immunocompromised people

Context

- This guidance provides information about the use of the COVID-19 vaccines for clinicians involved with the care of cancer patients.
- People with cancer are at increased risk of contracting COVID-19, at greater risk of serious infection and at increased risk of death than the general population [1-8]. The risk of infection and poor outcomes is particularly high for people with haematological malignancies and lung cancer [6 9-11].
- There is currently limited evidence on the use of COVID-19 vaccines in people with cancer. This guidance uses the best available evidence currently available, extrapolation from other vaccinations and expert consensus, and will be updated as new information and data become available.
- This guidance should be used alongside the Ministry of Health general COVID-19 vaccine information and COVID-19 vaccine updates for the health sector.

1. When will people with cancer be able to receive the vaccine?

The vaccine roll-out includes four groups:

- Group 1: Border and managed isolation and quarantine (MIQ) workers and the people they live with
- Group 2: Frontline workers and people living in high-risk settings (including those living in Counties Manukau DHB who are ≥ 65 years or have an underlying health condition)
- Group 3: People at high risk of serious outcomes or illness
    - This includes people over the age of 65 years
    - People under the age of 65 years who have any cancer, excluding basal and squamous skin cancers if not invasive
- Group 4: General population

Updates on the vaccine roll-out plan and timing can be found here.

The following people are considered at highest risk and should be prioritised to receive the vaccine as part of Group 3:

- people with cancer who are undergoing active chemotherapy

- people with cancer who are undergoing radiation therapy with curative intent and have a total radiation dose and field size that could affect the immune system
- people with cancers of the blood or bone marrow such as leukaemia, 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 6 months or who are still taking immunosuppression drugs
- people with incurable cancer with a palliative focus to their care, where vaccination is clinically appropriate.

Te Aho o Te Kahu recognises the importance of Treaty of Waitangi responsibilities and equity in the COVID-19 response. Within the above high-risk group, Te Aho o Te Kahu supports the prioritisation of Māori and Pacific peoples with cancer.

2. What vaccine is being rolled out?

The primary vaccine provider is now Pfizer/BioNTech, which is an mRNA-based vaccine and has been approved for use in New Zealand.

The Government has Advance Purchase Agreements in place for three other types of vaccines:

1. Oxford/ AstroZeneca (vector vaccine, adenovirus)
2. Novavax (Protein sub-unit vaccine)
3. Janssen Pharmaceutica (vector vaccine, adenovirus)

All agreements are subject to the vaccines successfully completing clinical trials and being approved by Medsafe.

None of the vaccines are live virus vaccines. More information on the types of vaccines is available here.

3. Should people with cancer receive the COVID-19 vaccine?

Yes. Whilst there is still limited data on vaccine immunogenicity and efficacy in the cancer population, current research from Israel suggests that 90% of patients with solid tumours undergoing active intravenous anticancer treatment exhibited adequate antibody response following two doses of vaccine[12]. Research from the UK indicates poor immunogenicity for cancer patients after a single dose of vaccine; however, this improved considerably following the 2nd dose[13]. **It is imperative that cancer patients receive the 2nd dose of vaccine in line with manufacturers guidance**.

Given the high risk of severe infection from COVID-19 for people with cancer, the benefits of vaccination are believed to outweigh any uncertainty around vaccine efficacy. The

vaccine is currently being rolled out rapidly internationally, including to people with cancer and there have been no reported safety concerns.

International consensus is that people with cancer should be prioritised for COVID-19 vaccination:

- **European Society of Medical Oncology (ESMO)** https://www.esmo.org/covid-19-and-cancer/covid-19-vaccination
- **National Comprehensive Cancer Network (NCCN)** https://www.nccn.org/covid-19/pdf/COVID-19_Vaccination_Guidance_V1.0.pdf
- **UK Chemotherapy Board** https://b-s-h.org.uk/media/19241/clinician-faqs-and-guidance-on-covid19-vaccine-for-patients-receiving-sa_.pdf
- **American Society of Clinical Oncology (ASCO)** https://www.asco.org/asco-coronavirus-resources/covid-19-patient-care-information/covid-19-vaccine-patients-cancer

In line with other vaccinations, it is possible that people who are immunocompromised may not mount as robust an immune response as others. For this reason, consideration should be given to the timing of vaccination in relation to therapy in order to maximise response (as outlined below).

In addition, it is recommended that:

- patients are encouraged to continue good infection prevention and control measures even after receiving the vaccine, including good hand hygiene and staying away from others who are unwell.
- household and family members should be vaccinated when the vaccine is made available to them to reduce the risk of infection.

4. Should immunocompromised cancer patients receive a third dose of the vaccine?

There is increasing evidence that people with immunocompromise may not produce a sufficiently strong immune response after two doses of Pfizer/BioNTech COVID-19 vaccine and may gain benefit from a third dose[13-21].

The Ministry of Health COVID-19 Technical Advisory Group has recommended that individuals aged 12 years and older with severe immunocompromise receive a third primary dose of Pfizer/BioNTech COVID-19 vaccine.

This is a third primary dose and is not considered a “booster” dose.

There are specific eligibility criteria to define who may be considered severely immunocompromised which can be found here.

The rollout of this third dose is being managed by the Ministry of Health. Further details will be updated on the Ministry of Health website.

5. Is there an optimal time to administer the vaccine relative to cancer treatment?

The patient's ability to mount an immune response should be considered regarding timing of vaccination. However, in the context of the globally more common and more transmissible Delta variant, the decision around timing may fall in favour of vaccination even in the setting of significant immunosuppression. This is particularly relevant in the context of community transmission.

Critical cancer treatment should not be held or paused for vaccinations.

Considerations for those on cytotoxic chemotherapy for solid tumours

There is limited data on the optimal timing of vaccination in relation to chemotherapy [22-24]. If there is the option of choosing the timing of the vaccination, it is recommended to deliver the vaccine at the furthest point from the immunosuppressing effect of cytotoxic treatment during a given cycle.

- If feasible, for patients planned for but not yet on immunosuppressive cancer therapy, time first dose of vaccine to be at least 2 weeks prior to initiation of therapy, if that does not delay commencing therapy, to maximise time for seroconversion.
- If feasible, for patients already on cytotoxic chemotherapy, time first dose of vaccine in between chemotherapy cycles, away from nadir.
- If feasible, for patients completing cytotoxic therapy, time first dose of vaccine to be given after therapy complete and nadir resolved [22].

If the above is not feasible then the recommendation is to avoid giving the COVID-19 vaccine on the same day as chemotherapy, noting that this is based on extrapolated information (from influenza vaccine) on efficacy of the vaccine rather than safety [25].

Considerations for those on immune checkpoint inhibitors

There is limited data on the immunogenicity of mRNA vaccines in people with cancer on immune checkpoint inhibitors (ICIs). An Israeli study of cancer patients being treated with ICIs found that there were no immune-related side effects amongst 134 patients who received two doses of the COVID-19 vaccine, and the side-effect profile was similar for cancer patients and for healthy controls[26].

There is a theoretical risk of exacerbated immune-related adverse events in patients receiving immune checkpoint inhibitors; however, subsequent studies of the influenza vaccine have not reproduced the adverse events initially raised [27-29].

The only currently listed contraindication to administering the Pfizer vaccine is hypersensitivity to the active substance or to any of the excipients listed on the Medsafe datasheet https://www.medsafe.govt.nz/profs/Datasheet/c/comirnatyinj.pdf

It is recommended that patients on immune checkpoint inhibitors receive the COVID-19 vaccine.

Considerations for cancer-related surgery

There are no specific timing recommendations for vaccine efficacy for people undergoing cancer surgery.

However, given that potential side-effects of the vaccine may be difficult to distinguish from potential post-operative complication symptoms (eg fever), it is recommended that major surgery should occur separately to vaccine administration, by a few days to a week.

Considerations for those with haematological malignancy

If feasible, patients requiring treatment for a haematological malignancy should be vaccinated at least two weeks before immunosuppressive treatments, **but this should not delay urgent treatment**.

Given the high mortality associated with COVID-19 infection patients with haematological malignancies, the benefit of vaccination is considered to outweigh the risk of impaired immune response in this patient group.

For all immunosuppressed/immunocompromised patients receiving the vaccine, it is essential to advise that they may not be protected by COVID-19 vaccination, and that they must adhere closely to hand hygiene, physical distancing and mask-wearing guidance.

The Haematology Society of Australia and New Zealand have released a consensus position statement regarding COVID-19 vaccination in haematology patients.

Considerations for people receiving B-cell depleting therapy or who have recently undergone stem cell transplantation

Previous advice was that vaccination should be delayed for at least three months after B cell depleting therapy or stem cell transplantation.

While patients with haematological malignancy and immunosuppression may not mount an adequate immune response to vaccination, some will[20 30 31] and there are minimal known additional safety concerns in this group. Overall, the risk/benefit of vaccination is thought to weigh in favour of vaccination considering the risk of community transmission with the highly transmissible Delta COVID-19 variant.

The following advice takes into account the context of the delta variant and community transmission.

For people currently or recently receiving B-cell depleting therapy[1]:

[1] For example, rituximab, obinutuzumab, venetoclax, BTK inhibitor, anti-B-cell BiTE therapy or anti-B-cell CAR T-cell therapy

- If therapy can safely be deferred by at least 5 weeks without compromising outcomes, defer treatment (to allow for two vaccine doses 3 weeks apart, plus two weeks after the second dose)
- If treatment is urgent, proceed with treatment and vaccinate as soon as possible during treatment
- If currently receiving treatment, or if patient received anti-B-cell monocolonal antibodies, bispecific T cell engager (BiTE) therapy or CAR T-cell therapy within the last year, proceed with vaccination.

For autologous stem cell transplantation:

- Vaccinate after neutrophil and platelet engraftment

For allogeneic stem cell transplantation:

- Vaccinate from day 90 (even if still on immunosuppression, although vaccine responses likely to be reduced)

Australia and New Zealand Transplant and Cellular Therapies (ANZTCT) have also produced COVID-19 vaccine information that can be found here.

Lymphoma, Chronic Lymphocytic Leukaemia and Multiple Myeloma
Some patients with lymphoma, CLL or multiple myeloma may not require immediate treatment. Significant delay to starting treatment - in an attempt to increase potential immune response to the vaccine – is not recommended. Decisions around vaccine and treatment timing should be based on clinical judgement and discussion of risk and benefits with the patient [32].

Acute Leukaemias, Myelodysplastic Syndrome and Myeloproliferative disorders
Vaccination should not delay definitive therapy for acute and urgent conditions. For patients in remission, vaccination should occur as soon as possible, whilst considering thrombocytopenia and the associated risk of bleeding [32].

Further specific examples relating to haematological malignancies are available in the Haematology Society of Australia and New Zealand guidance [32].

5. Should I test antibody levels to see if my patient has responded to vaccination?

The routine testing for antibodies is not currently recommended.

6. What about patients with bleeding disorders or on anticoagulation?

The Haematology Society of Australia and New Zealand have released guidance on vaccine administration in patients with bleeding risk. Key considerations include:

- patients on standard anticoagulation with warfarin can receive intra-muscular injections if the most recent INR is ≤3.0
- patients with thrombocytopenia may bleed or bruise at the site of the injection site. To reduce this risk, it is recommended that the platelet count is kept ≥30x109 /L and that prolonged pressure at the injection site is applied for five minutes.

The Immunisation Handbook also has general guidance on vaccine administration for patients with thrombocytopenia, bleeding disorders or who are on anticoagulant therapy.

7. Can people on clinical trials receive the vaccine?

There are no general limitations on COVID-19 vaccination for patients enrolled in clinical trials. If a limitation is specifically stated in the study protocol inclusion/exclusion criteria this should be discussed with the study Primary Investigator and the patient[33].

8. Should children with cancer receive the COVID-19 vaccine?

The Pfizer/BioNTech vaccine is now approved for 12–15-year-olds, as of 21st June 2021.

It is recommended that household contacts and caregivers of children with cancer receive the vaccine when available.

9. Are there any considerations for people with a history of cancer?

People who have been discharged from oncology and haematology services can receive the vaccine when offered.

10. Are there any considerations for people with lymphoedema?

People with lymphoedema of the arm are advised to get the vaccine in the other arm[34].

As a precaution, people at risk of lymphoedema (e.g. people who have had axillary node clearance) should also receive the vaccine in the unaffected limb if possible.

11. Are there considerations for people undergoing radiological imaging following vaccination?

Following vaccination with the COVID-19 vaccine some people may develop an immune response that results in axillary lymphadenopathy[35]. This may show up on radiological imaging, including routine breast imaging, and could cause diagnostic confusion. On balance of risk, the Royal Australian and New Zealand College of Radiologists and Breastscreen Aotearoa **do not** recommend delaying breast screening[35 36]. Patients with unilateral axillary lymphadenopathy should be managed on a case-by-case basis.

Transient FDG uptake in normal lymph nodes is known to occur following multiple different intramuscular vaccinations[37-39]. This phenomenon is now being seen with the COVID-19 vaccination [40 41] and given the large-scale rollout of the COVID-19 vaccination, may be observed more frequently. Clinicians should take this into consideration when planning PET/CT scans and when interpreting results. When receiving a PET/CT scan, patients should be asked if they have received a vaccination and in which arm. Additional information: https://covid.immune.org.nz/faq/can-i-have-covid-19-vaccination-ct-scan

12. FAQs for people with cancer

Public facing information will be published here.

This will include the following FAQs, along with links to the general Ministry of Health page.

Frequently Asked Questions (FAQs)

People with cancer and the COVID-19 vaccines

Are people with cancer more vulnerable to COVID-19 than the general population?

People with cancer are at an increased risk of getting COVID-19 and have a greater risk of serious infection if they do get COVID-19.

When will people with cancer be able to receive a COVID-19 vaccine?

People with cancer are in Group 3. Group 3 includes:

- people over the age of 65 years
- people under the age of 65 years who have any cancer, excluding basal and squamous skin cancers if not invasive

Vaccination for those in Group 3 is currently available. Further information on the timing of the roll out is on the Ministry of Health website.

What are the side effects of the vaccine for people with cancer?

The general information on side-effects from the COVID-19 vaccine can be found here.

There is currently no evidence that people with cancer experience different or worse side effects than the general population.

Should I get the COVID-19 vaccine if I am currently receiving cancer treatment?

Yes.

Talk to your cancer doctor, as depending on what treatment you are on, they may want to time the vaccine to be delivered at a certain point in your treatment cycle.

Will the COVID-19 vaccine affect or interact with cancer treatments?

There is no evidence currently to suggest that the COVID-19 vaccine interacts with cancer treatments.

Decisions around timing of the vaccine are about making sure the vaccine is as effective as possible, rather than concerns around how it will interact with cancer treatments.

I had cancer 5 years ago, is it OK for me to get the vaccine?

If you have finished your cancer treatment and have been discharged from your hospital specialist, you should get the vaccine when it is offered to you.

If you have any concerns you can discuss these with your GP.

Who should people with cancer talk to about receiving the COVID-19 vaccine?

We recommend that you talk to your cancer doctor if you have questions or concerns.

If you have been discharged from hospital services, we recommend you talk to your GP if you have questions or concerns.

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References

1. Tian Y, Qiu X, Wang C, et al. Cancer associates with risk and severe events of COVID-19: A systematic review and meta-analysis. *International journal of cancer* 2021;148(2):363-74.
2. Liang W, Guan W, Chen R, et al. Cancer patients in SARS-CoV-2 infection: a nationwide analysis in China. *The lancet oncology* 2020;21(3):335-37.
3. Yang F, Shi S, Zhu J, et al. Clinical characteristics and outcomes of cancer patients with COVID-19. *Journal of medical virology* 2020;92(10):2067-73.
4. Rüthrich MM, Giessen-Jung C, Borgmann S, et al. COVID-19 in cancer patients: clinical characteristics and outcome—an analysis of the LEOSS registry. *Annals of hematology* 2020:1-11.
5. Desai A, Gupta R, Advani S, et al. Mortality in hospitalized patients with cancer and coronavirus disease 2019: A systematic review and meta-analysis of cohort studies. *Cancer* 2020
6. Wang Q, Berger NA, Xu R. Analyses of Risk, Racial Disparity, and Outcomes Among US Patients With Cancer and COVID-19 Infection. *JAMA oncology* 2020
7. García-Suárez J, De La Cruz J, Cedillo Á, et al. 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* 2020;13(1):1-12.
8. Kuderer NM, Choueiri TK, Shah DP, et al. Clinical impact of COVID-19 on patients with cancer (CCC19): a cohort study. *The Lancet* 2020;395(10241):1907-18.
9. Williamson EJ, Walker AJ, Bhaskaran K, et al. Factors associated with COVID-19-related death using OpenSAFELY. *Nature* 2020;584(7821):430-36. doi: 10.1038/s41586-020-2521-4
10. Venkatesulu BP, Chandrasekar VT, Girdhar P, et al. A systematic review and meta-analysis of cancer patients affected by a novel coronavirus. *medRxiv* 2020
11. Vijenthira A, Gong IY, Fox TA, et al. Outcomes of patients with hematologic malignancies and COVID-19: a systematic review and meta-analysis of 3377 patients. *Blood, The Journal of the American Society of Hematology* 2020;136(25):2881-92.
12. Massarweh A, Eliakim-Raz N, Stemmer A, et al. Evaluation of Seropositivity Following BNT162b2 Messenger RNA Vaccination for SARS-CoV-2 in Patients Undergoing Treatment for Cancer. *JAMA Oncology* 2021 doi: 10.1001/jamaoncol.2021.2155
13. Monin L, Laing AG, Muñoz-Ruiz M, et al. Safety and immunogenicity of one versus two doses of the COVID-19 vaccine BNT162b2 for patients with cancer: interim analysis of a prospective observational study. *The Lancet Oncology* 2021;22(6):765-78. doi: 10.1016/S1470-2045(21)00213-8
14. Longlune N, Nogier MB, Miedougé M, et al. High immunogenicity of a messenger RNA-based vaccine against SARS-CoV-2 in chronic dialysis patients. *Nephrology Dialysis Transplantation* 2021;36(9):1704-09. doi: 10.1093/ndt/gfab193
15. Espi M, Charmetant X, Barba T, et al. Justification, safety, and efficacy of a third dose of mRNA vaccine in maintenance hemodialysis patients: a prospective observational study. *medRxiv* 2021:2021.07.02.21259913. doi: 10.1101/2021.07.02.21259913
16. Werbel WA, Boyarsky BJ, Ou MT, et al. Safety and Immunogenicity of a Third Dose of SARS-CoV-2 Vaccine in Solid Organ Transplant Recipients: A Case Series. *Annals of Internal Medicine* 2021 doi: 10.7326/L21-0282
17. Kamar N, Abravanel F, Marion O, et al. Three Doses of an mRNA Covid-19 Vaccine in Solid-Organ Transplant Recipients. *New England Journal of Medicine* 2021;385(7):661-62. doi: 10.1056/NEJMc2108861
18. Chodick G, Tene L, Rotem RS, et al. The Effectiveness of the Two-Dose BNT162b2 Vaccine: Analysis of Real-World Data. *Clinical Infectious Diseases* 2021 doi: 10.1093/cid/ciab438
19. Tenforde MW, Patel MM, Ginde AA, et al. Effectiveness of SARS-CoV-2 mRNA Vaccines for Preventing Covid-19 Hospitalizations in the United States. *medRxiv* 2021:2021.07.08.21259776. doi: 10.1101/2021.07.08.21259776

20. Herishanu Y, Avivi I, Aharon A, et al. Efficacy of the BNT162b2 mRNA COVID-19 vaccine in patients with chronic lymphocytic leukemia. *Blood* 2021;137(23):3165-73. doi: 10.1182/blood.2021011568
21. Agha M, Blake M, Chilleo C, et al. Suboptimal response to COVID-19 mRNA vaccines in hematologic malignancies patients. *medRxiv* 2021:2021.04.06.21254949. doi: 10.1101/2021.04.06.21254949
22. Kamboj M, Hohl T, Vardhana S, et al. MSK COVID-19 VACCINE INTERIM GUIDELINES FOR CANCER PATIENTS.
23. Pollyea DA, Brown JM, Horning SJ. Utility of influenza vaccination for oncology patients. *Journal of clinical oncology* 2010;28(14):2481-90.
24. Keam B, Kim MK, Choi Y, et al. Optimal timing of influenza vaccination during 3-week cytotoxic chemotherapy cycles. *Cancer* 2017;123(5):841-48.
25. UK Chemotherapy Board. Clinician Frequently Asked Questions (FAQs) and guidance on COVID-19 vaccine for patients receiving Systemic Anti-Cancer Therapy. *Available from: **https://wwwukchemotherapyboardorg/publications*** 2021
26. Waissengrin B, Agbarya A, Safadi E, et al. Short-term safety of the BNT162b2 mRNA COVID-19 vaccine in patients with cancer treated with immune checkpoint inhibitors. *The Lancet Oncology* 2021;22(5):581-83. doi: 10.1016/S1470-2045(21)00155-8
27. Failing JJ, Ho TP, Yadav S, et al. Safety of influenza vaccine in patients with cancer receiving pembrolizumab. *JCO oncology practice* 2020;16(7):e573-e80.
28. Chong CR, Park VJ, Cohen B, et al. Safety of inactivated influenza vaccine in cancer patients receiving immune checkpoint inhibitors. *Clinical Infectious Diseases* 2020;70(2):193-99.
29. Wijn DH, Groeneveld GH, Vollaard AM, et al. Influenza vaccination in patients with lung cancer receiving anti–programmed death receptor 1 immunotherapy does not induce immune-related adverse events. *European journal of cancer* 2018;104:182-87.
30. Diefenbach C, Caro J, Koide A, et al. Impaired Humoral Immunity to SARS-CoV-2 Vaccination in Non-Hodgkin Lymphoma and CLL Patients. *medRxiv* 2021 doi: 10.1101/2021.06.02.21257804 [published Online First: 2021/06/09]
31. Chevallier P, Coste-Burel M, Le Bourgeois A, et al. Safety and immunogenicity of a first dose of SARS-CoV-2 mRNA vaccine in allogeneic hematopoietic stem-cells recipients. *eJHaem*;n/a(n/a) doi: **https://doi.org/10.1002/jha2.242**
32. Haematology Society of Australia and New Zealand. COVID-19 Vaccination in Haematology Patients: An Australia and New Zealand Consensus Position Statement. ***https://hsanzorgau/resources/Documents/News/Final%20COVID%20Vax%20in%20Haem%20Patients%202nd%20Feb%202021pdf*** 2021
33. Yap TA, Siu LL, Calvo E, et al. SARS-CoV-2 vaccination and phase 1 cancer clinical trials. *The Lancet Oncology* 2021;22(3):298-301. doi: **https://doi.org/10.1016/S1470-2045(21)00017-6**
34. British Lymphology Society. Consensus document on COVID-19 vaccination for patients with lymphoedema (Updated 25th May 2021). ***https://wwwtheblscom/public/uploads/documents/document-42621622017262pdf*** 2021
35. The Royal Australian and New Zealand College of Radiologists. The Royal Australian and New Zealand College of Radiologists Statement on Vaccine Induced Adenopathy (9 June 2021). **https://www.ranzcr.com/our-work/coronavirus/position-statements-and-guidance**, 2021.
36. Time to Screen. COVID-19 vaccination and breast screening [Available from: **https://www.timetoscreen.nz/breast-screening/covid-19-breast-screening/covid-19-vaccination-and-breast-screening/** accessed 5 July 2021 2021.
37. Shirone N, Shinkai T, Yamane T, et al. Axillary lymph node accumulation on FDG-PET/CT after influenza vaccination. *Annals of Nuclear Medicine* 2012;26(3):248-52. doi: 10.1007/s12149-011-0568-x

38. Coates EE, Costner PJ, Nason MC, et al. Lymph Node Activation by PET/CT Following Vaccination With Licensed Vaccines for Human Papillomaviruses. *Clinical Nuclear Medicine* 2017;42(5):329-34. doi: 10.1097/rlu.0000000000001603
39. Panagiotidis E, Exarhos D, Housianakou I, et al. FDG uptake in axillary lymph nodes after vaccination against pandemic (H1N1). *Eur Radiol* 2010;20(5):1251-3. doi: 10.1007/s00330-010-1719-5 [published Online First: 2010/02/27]
40. McIntosh LJ, Bankier AA, Vijayaraghavan GR, et al. COVID-19 Vaccination-Related Uptake on FDG PET/CT: An Emerging Dilemma and Suggestions for Management. *American Journal of Roentgenology* 2021 doi: 10.2214/AJR.21.25728
41. Eifer M, Eshet Y. Imaging of COVID-19 Vaccination at FDG PET/CT. *Radiology* 2021;299(2):E248-E48.