The Children & Young People's Cancer Association

Vaccination Guideline: For Children and Young People Treated for Cancer with Standard-Dose Chemotherapy and Haemopoietic Stem Cell Transplant (HSCT)

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STAKEHOLDER ORGANISATIONS

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DECLARATION OF CONFLICTS OF INTEREST

Professor Paul T. Heath is a member of The Joint Committee on Vaccination and Immunisation

Executive summary

Table 1: Vaccination schedule after completion of standard-dose chemotherapy

Time after Completion of Treatment	Pathogen protected against	Vaccine
From 3 Months	Seasonal Influenza (SIIV during first 3 months after COT)	LAIV *(live vaccine)*
	SARS-CoV-2	SARS-CoV-2 vaccine (per national guidance)
	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B	DTaP/IPV/Hib/HepB
	Meningococcal B	Men B
	Streptococcus pneumoniae	PCV20
	Meningococcal ACWY	Men ACWY-conjugate
	Measles, Mumps, Rubella, Varicella	MMRV[1] *(live vaccine)*
	Human Papillomavirus	HPV-9[2]

Vaccines: DTaP = Diphtheria/ Tetanus/ acellular Pertussis, Hib = H. influenzae b conjugate, HepB = Hepatitis B, HPV-9 = 9-valent Human papillomavirus vaccine, IPV = Inactivated polio virus, LAIV = Live attenuated influenza vaccine, Men B = Meningococcal B, Men ACWY = Meningococcal ACWY conjugate, MMRV = Measles/Mumps/Rubella/Varicella, PCV20 = 20-valent Pneumococcal conjugate, SIIV = Seasonal inactivated influenza vaccine

If PCV20 vaccine is not available, offer PCV13 (13-valent Pneumococcal conjugate vaccine).

[1] If no MMR or one MMR vaccine dose prior to diagnosis, then give two doses of MMRV vaccine.
If completed two doses MMR vaccine prior to diagnosis, then 1 x MMR and 2 x V components required so give two doses MMRV vaccine. Minimum four weeks interval between MMRV vaccine doses.
[2] HPV-9 vaccine should be offered to girls and boys ≥12 years old: For HPV vaccine naïve, two doses of HPV vaccine should be given at 0 and 4-6 months from starting vaccination. For girls and boys that completed the course prior to diagnosis, a single dose should be given.

Multiple inactivated and live vaccines can be co-administered.

Table 2: Re-Vaccination Schedule for HSCT Recipients

Time post-HSCT	Pathogens Protected Against	Vaccine
Annually from 6 months (consider from 3 months if peak transmission period)	Seasonal Influenza SARS-CoV-2	SIIV SARS-CoV-2 vaccine (as per national guidance)
6 months	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B Meningococcal B *Streptococcus pneumoniae* Human Papillomavirus[1]	DTaP/IPV/Hib/HepB (dose 1) MenB (dose 1) PCV20 (dose 1) HPV-9 (dose 1)
7 months	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B Meningococcal B *Streptococcus pneumoniae* Human Papillomavirus	DTaP/IPV/Hib/HepB (dose 2) MenB (dose 2) PCV20 (dose 2) HPV-9 (dose 2)
8 months	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B Meningococcal ACWY[2] *Streptococcus pneumoniae*	DTaP/IPV/Hib/HepB (dose 3) Men ACWY (dose 1) PCV20 (dose 3)
12 months	Human Papillomavirus	HPV-9 (dose 3)
18 months	Meningococcal ACWY [2] Meningococcal B *Streptococcus pneumoniae* *Haemophilus influenzae* b	Men ACWY (dose 2) MenB (Booster dose) PCV20 (Booster dose) DTaP/IPV/Hib/HepB
24 months	Measles, Mumps, Rubella, Varicella [3,4]	MMRV (dose 1) *live vaccine*
30 months	Measles, Mumps, Rubella, Varicella	MMRV (dose 2) *live vaccine*
3 years	Diphtheria, tetanus, pertussis polio	DTaP/IPV
14 years	Diphtheria tetanus, polio	Td/IPV

Vaccines: DTaP = Diphtheria/ Tetanus/ acellular Pertussis, dT = Low dose diphtheria/ Tetanus, Hib = H. influenzae b conjugate, HepB = Hepatitis B, HPV-9 = 9-valent Human papillomavirus vaccine, IPV = Inactivated polio virus vaccine, Men B = Meningococcal B, Men ACWY = Meningococcal ACWY conjugate, MMRV = Measles/Mumps/Rubella/Varicella, PCV20 = 20-valent Pneumococcal conjugate vaccine, SIIV = Seasonal inactivated influenza vaccine
If PCV20 vaccine is not available, offer PCV13 (13-valent Pneumococcal conjugate vaccine)

[1]HPV-9 vaccine, for patients aged >12 years, Three dose schedule is recommended for immunocompromised patients, two doses with one month interval and then a third dose 4-6 months after the first dose.
[2] HSCT Patients at risk from meningococcal disease therefore first dose of quadrivalent conjugate vaccine recommended at 8 months post HSCT.
[3] Criteria for administration of live vaccines. i) 24 months post HSCT ii) No active GvHD iii) No Immune suppressive therapy for 12 months iv) No IVIg in last 3 months. [4] If criteria for live vaccines met can consider vaccinating from 18 months post HSCT if community outbreak of Measles. Minimum four weeks interval between MMRV doses.

Multiple inactivated and live vaccines can be co-administered.

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List of abbreviations and acronyms

ACRONYM	DEFINITION
CAR-T	Chimeric antigen receptor T-cell therapy
DTaP	Diphtheria/ Tetanus/ acellular Pertussis
GP	General Practitioner
HepB	Hepatitis B
Hib	*Haemophilus influenzae* type b
HPV-9	9-valent Human papillomavirus
HSCT	Haemopoietic Stem Cell Transplant
IgG	Immunoglobulin G
IPV	Inactivated Polio Virus
JCVI	Joint Committee on Vaccination and Immunisation
LAIV	Live attenuated influenza vaccine
Men B	Meningococcal B
Men ACWY	Meningococcal ACWY
MMR	Measles/ Mumps/ Rubella
MMRV	Measles/Mumps/Rubella/Varicella
PCV20	20-valent Pneumococcal conjugate
PCV13	13-valent Pneumococcal conjugate
SIIV	Seasonal inactivated influenza vaccine
UKHSA	United Kingdom Health Security Authority
VPD	Vaccine Preventable Disease
VZV	Varicella Zoster Virus

1. Introduction

1.1 Aims and Objectives

The aim of this guideline is to draw upon the current evidence base and existing guidelines and align this with the United Kingdom (UK) national vaccine schedule and vaccine availability to recommend a pragmatic and standardised vaccination schedule for children and young people (CYP) treated for cancer with standard dose chemotherapy and with haematopoietic stem cell transplant. Where no evidence exists, to provide guidance based on expert consensus.

This guideline also provides guidance about vaccinations for household members/ close contacts. We have not included guidance for common travel vaccinations; this should be reviewed on case-by-case basis. In general, we recommend avoiding live vaccines (risk of vaccine related disease), and polysaccharide vaccines (likely to induce poor immune responses) whilst the patient is considered immunocompromised.

The recommendation for vaccination from the managing medical team has been identified as an important cue for patients/ their carers. We strongly recommend vaccination for children and young people treated for cancer; providing a copy of the vaccination schedule (appendices 1 and 2) for your patient/ their carer and their primary care practice/ general practitioner (GP) will promote this recommendation.

1.2 Scope and Target Population

The primary audience consists of health professionals in the UK directly involved in managing children and young people treated for cancer, and children and young people treated for cancer and their families.

2. Methodology of guideline development

These guidelines were developed according to standards set out by the CCLG, in accordance with NICE accredited standards. The guideline development search strategies and selection criteria are set out in Appendix 3.

3. Changes from previous guideline

Changes in the epidemiology of infectious diseases and the introduction of new vaccines and/ or availability of vaccines mean that adjustments need to be made to the routine childhood vaccination schedule, and hence to the vaccination schedule for CYP treated for cancer.

3.1 July 2025

From July 2025, discontinuation of the manufacture of the Menitorix (Hib/ MenC) vaccine has resulted in changes to the national vaccination schedule. Whilst vaccination against Meningococcus group C (Men C) in early childhood is no longer considered necessary, vaccination against *Haemophilus influenzae* type b (Hib) in the second year of life needs to continue. For the national childhood vaccination schedule, the Joint Committee on Vaccination and Immunisation (JCVI) recommend an additional dose of a Hib-containing vaccine, the hexavalent combination (DTaP/IPV/Hib/HepB) vaccine which should be administered at age 18 months.

Patients treated with standard-dose chemotherapy: Should be offered the DTaP/IPV/Hib/HepB vaccine. With regards to children above 10 years of age that have completed treatment with standard dose chemotherapy, they can have a booster dose with DTaP/IPV/Hib/HepB; we have balanced the potential risk of reactogenicity in older children to the higher dose diphtheria toxoid in this vaccine with the need for Hib-conjugate vaccine (the risk of invasive Hib is low but remains in older children and adults (UKHSA data, June 2025)).

HSCT recipients: Are considered 'never vaccinated' as their immune system reconstitutes and they need a full re-vaccination programme; the higher diphtheria toxoid dose should not be an issue irrespective of recipient age.

3.2 January 2026

3.2.1 Measles/ Mumps/ Rubella/ Varicella (MMRV) vaccine

From January 2026, Measles/ Mumps/ Rubella (MMR) vaccine replaced with MMR/ Varicella (MMRV) vaccine in the national childhood vaccination schedule. Varicella zoster virus (VZV) is responsible for primary disease as varicella (chickenpox) and reactivation as Herpes zoster (shingles). The immune response to the MMRV vaccine after one dose demonstrates high seroconversion rates, with approximately 87% of children developing antibodies against varicella, and more than 90% developing antibodies against measles, mumps, and rubella. Following the second dose, seroconversion improves further, reaching approximately 99-100% for all four.

Licensed MMRV vaccines are ProQuad® or Priorix-Tetra®.

The titre of VZV (vOka strain of live attenuated virus) is the same (Priorix-Tetra®) or approx. 7 x higher (ProQuad®) in MMRV vaccine than in the monovalent varicella vaccines. The MMRV vaccine has been proven safe. There is a small increase in febrile seizures in infants receiving their first dose of MMRV. There are no published studies that have examined the immunogenicity or safety of MMRV vaccine in individuals treated for cancer. Patients treated for cancer are at increased risk of skin rash after the first dose and in some they may also have a more typical varicella-like infection. MMRV is a live vaccine, hence should not be given during immunosuppressive treatment. Vaccination after completion of standard dose chemotherapy and HSCT should be undertaken as detailed below.

We do not know how long the monovalent varicella vaccine will be available in the UK; hence, we recommend MMRV vaccine. However, whilst the monovalent varicella vaccine is available consideration can be given to using combination of MMR and monovalent Varicella vaccines on a case-by-case basis.

After completion of standard dose chemotherapy:

- If no MMR or one MMR vaccine dose prior to diagnosis, then give two doses of MMRV vaccine
- If completed two doses MMR vaccine prior to diagnosis, then 1 x MMR and 2 x V components required so give two doses MMRV vaccine

With time, as most children will have received two doses of MMRV vaccine prior to diagnosis, the recommendation after treatment can be adjusted accordingly.

For HSCT recipients:
Two doses MMRV vaccine recommended. If Varicella IgG positive (or Herpes zoster (shingles) as clinical indicator of varicella immunity) after HSCT, either two doses MMR or two doses MMRV vaccine (the varicella component of MMRV may boost varicella immunity akin to HSCT recipients aged above 18 years receiving the recombinant zoster vaccine) and prevent/ reduce reactivation (Herpes zoster).

MMRV vaccine should be given to household members/ close contacts as per the national vaccination schedule. Transmission of attenuated varicella vaccine virus from vaccinee to immunocompromised close contact has been documented, but the risk is low. Should the vaccinee develop a varicella like rash (usually within one month of vaccination), the rash should be covered and as a precautionary measure, the patient should avoid direct contact with the vaccinee/ their rash until the rash is dry and crusted. If the rash is disseminated, the risk of transmission is higher, and varicella prophylaxis should be provided for the immunocompromised contact as per the national guideline on post-exposure prophylaxis (PEP) for varicella or shingles, July 2025 (https://www.gov.uk/government/publications/post-exposure-prophylaxis-for-chickenpox-and-shingles/guidelines-on-post-exposure-prophylaxis-pep-for-varicella-or-shingles-january-2023#sectiond).

3.2.2 Pneumococcal conjugate vaccine

The 13-valent pneumococcal conjugate vaccine (PCV13) replaced with 20-valent pneumococcal conjugate vaccine (PCV20) for clinical risk groups (Pneumococcal: The Green Book, Immunisation against infectious disease). This would include patients treated for cancer, particularly HSCT recipients. PCV20 is recommended, if it is not available then PCV13 should be offered.

3.2.3 Live Attenuated Influenza Vaccine

The live attenuated influenzae vaccine (LAIV) is recommended (for eligible CYP) from three months (align with the other vaccines recommended at this time point) after completion of standard dose chemotherapy. The published evidence base for recommending LAIV at this time point is currently very limited. Our decision to change is based on expert consensus.

4. Introduction – Vaccinations for Children and Young People treated with standard-dose chemotherapy and Haemopoietic Stem Cell Transplantation (HSCT)

Over the last three decades, the survival of children and young people with cancer has significantly improved because of a number of factors, such as multimodality and often more intensive (hence more immune suppressive) treatment regimens and improved supportive care. Antineoplastic treatment usually involves chemotherapy, radiotherapy, or a combination of both. The majority of children with cancer are treated with standard-dose chemotherapy, but children with high-risk haematologic malignancies, children with certain solid tumours, and children with disease relapse often require high dose chemotherapy (+/- radiotherapy) followed by haematopoietic stem cell transplant (HSCT). Some treatment regimens include radiotherapy; if the radiotherapy field includes the spleen (with a dose >10 Gy) then functional hyposplenia or asplenia is likely. These different forms of treatment have different influences on the immune system and the degree of immunodeficiency. Immune alteration is reflected by decreases in neutrophils, lymphocytes, immunoglobulin levels, and specific antibodies against previous infections and vaccinations. This results in increased susceptibility to and severity of infections. Most vaccine-preventable diseases (VPD) are now fortunately rare; however, the risk for some remains significant, in part because of increases in migration and travel, and poor vaccine update. VPD can be associated with high morbidity and mortality, particularly in immunocompromised patients. In view of the immune deficiency of children treated for cancer, particularly HSCT recipients, it is important to ensure that they are protected against VPD both during and after completion of treatment. This can be achieved by optimising the vaccination strategy during immunosuppressive theatment, and after completion of treatment at a time point that balances immune recovery to avoid vaccine side effects (especially for live vaccines) and enable optimal immune response. In view of the diversity of malignant diseases and their treatment protocols, it is difficult to propose different schedules for each disease. Rather, it is sensible to divide them into children treated with standard-dose chemotherapy and children treated with high-dose chemotherapy followed by allogeneic or autologous HSCT. We will focus on these treatment modalities for this guideline.

In view of the immunodeficiency and the reduction/ loss of vaccine-antigen specific antibody in children treated for cancer, it is important to ensure that they are adequately protected against VPD. Although the burden of VPD is generally low in a highly vaccinated population such as the UK, the risk at an individual level for some VPD may still be substantial. The aim of this guideline is to draw upon the current evidence base and existing guidelines and align this with the UK national vaccine schedule and vaccine availability in order to recommend a pragmatic and standardised vaccination schedule for children and young people treated for cancer with standard dose chemotherapy and with HSCT.

There are published studies demonstrating a reduction in specific antibody concentrations at completion of chemotherapy treatment (COT) and after HSCT to *Haemophilus influenzae* type b (Hib), Meningococcus C (Men C), tetanus, polio, measles, inactivated influenza and pneumococcal vaccines. However, there are no / limited published data for this group of patients on immunogenicity to Human Papilloma Virus (HPV) vaccine, Meningococcal serogroup A, B, W and Y, and SARS-CoV2.

Cancer treatment is associated with an increased risk of acquisition and persistence of HPV infection and of subsequent development of HPV-associated skin lesions (warts) and with cancer. HPV vaccine

is well established as highly immunogenic, efficacious and safe. The current national recommendation for the 9-valent HPV vaccine (HPV-9), is as a one-dose schedule for the routine (healthy) adolescent/ young adult vaccination programme, and a three-dose schedule for individuals who are immunocompromised. There are very few published studies looking at immune response to HPV vaccine and cancer treatment, particularly there are no published studies for HPV vaccine and treatment with standard dose chemotherapy. Our recommendation for patients treated with standard-dose chemotherapy to give one booster HPV vaccine dose (if previously vaccinated) or two doses 4-6 months apart (if HPV vaccine naïve) from three months after COT is largely based on expert opinion. During chemotherapy, if the patient is considered immunocompromised, then as per national guidance three doses of HPV vaccine should be offered. In view of national recommendations for immunocompromised patients and published data for HSCT recipients, we recommend that HSCT recipients aged 12 years and over are offered three doses of HPV vaccine. Pragmatically, to limit the number of vaccinations given at any one time point, we recommend commencing HPV vaccination from six months post-HSCT.

There are limited published data and little published guidance for children treated with other modalities such as chimeric antigen receptor T-cell therapy (CAR-T) or those receiving B-cell–depleting therapies (e.g. rituximab). The approach to vaccination (or re-vaccination) in a CAR-T recipient should be individualised in consultation with their treatment centre, based on the timing since completion of treatment, and if (and when) the child has previously undergone HSCT which influences whether either a standard chemotherapy booster or a re-vaccination schedule is recommended. In addition, many CAR-T recipients have ongoing B cell aplasia with hypogammaglobulinaemia. Such patients will be receiving intravenous immunoglobulin (IVIg) and the approach to their vaccination should be guided by their treatment centre.

The recommendation for vaccination from the managing medical team has been identified as an important cue for patients/ their carers. We strongly recommend vaccination for children and young people treated for cancer; providing a copy of the vaccination schedule (appendices below) for your patient/ their carer and their general practitioner (GP) will promote this recommendation.

5. Vaccinations for Children and Young People Treated with Standard-Dose Chemotherapy

5.1 Background

Different cancers require treatment with different combinations of chemotherapy agents. Therapy for a single disease is risk-stratified based on patient factors, extent of disease and tumour biology, so there may be variation in intensity of therapy for a single disease type. Therapy regimens that include agents such as cyclophosphamide, purine nucleoside analogues or corticosteroids are immunosuppressive; they particularly influence lymphocyte function. Some treatment regimens include radiation therapy; there are few data on the influence of radiotherapy on immunosuppression. If radiation therapy involves the spleen, functional hyposplenia or asplenia can result which increases susceptibility to infection with polysaccharide encapsulated bacteria.

Depending on the treatment regimen, B- and T-lymphocyte levels decrease during treatment; with an increase in number occurring one month after completion of chemotherapy. Total B- and T-lymphocytes usually recover, quantitatively and functionally, 3- 6 months after completion of chemotherapy. Normalisation of immunoglobulin levels can take up to one year after completion of treatment.

Clinical experience suggests that there is an increased risk for meningococcal infection in children who have been treated for cancer and therefore we recommend expediting vaccination with meningococcal ACWY-conjugate (Men ACWY) vaccine rather than waiting until age 14 years per the national vaccination schedule.

Until further data are available on immunity to vaccine antigens in specific disease types and treatment regimens, it is wise to follow the same vaccination recommendations for all patients treated with standard-dose chemotherapy.

5.2 Vaccinations for patients receiving standard-dose chemotherapy

Children are immunocompromised during chemotherapy and are susceptible to invasive infection. This is also a time in which they are less likely to achieve an optimal immune response to vaccination and furthermore, a period in which live vaccines, such as Measles-Mumps-Rubella-Varicella (MMRV), Rotavirus vaccine, Bacillus Calmette-Guerin (BCG), and live attenuated influenza vaccine (LAIV) pose the risk of causing vaccine-related disease. Non-live vaccines can be administered during chemotherapy. Studies that have evaluated antibody response to vaccines during chemotherapy have mostly done so during the maintenance phase of acute lymphoblastic leukaemia (ALL) therapy. Antibody responses during chemotherapy are usually impaired. Even so, non-live vaccines should be given according to the national childhood vaccination schedule, provided the child's general health is stable and avoiding periods of more intensive chemotherapy, neutropenia (neutrophil count $0.5x10^9$/L and below), and steroid pulses. This is particularly important for primary vaccinations to ensure at least some immunity in an otherwise nonimmune child.

The seasonal inactivated influenza vaccine (SIIV) is recommended annually provided the patient is well and has a neutrophil count above $0.5x10^9$/L. The latter is to avoid children with vaccine-associated fever being unnecessarily treated with antibiotics. Ideally, it would not be given within two weeks of more intensive chemotherapy or steroid pulses as the immune response may be sub-optimal.

5.3 Vaccination after completion of standard-dose Chemotherapy

In view of the reduction in vaccine-antigen specific antibody levels because of chemotherapy, booster vaccinations should be given after completion of chemotherapy. In terms of timing, the aim is to balance safety and immunogenicity (and efficacy). Vaccination after completion of chemotherapy results in good immune responses, with most recipients achieving protective antibody levels following a single dose of vaccine. Generally, from three months after completion of treatment should be safe and elicit protective antibody responses. A booster dose of each routine childhood vaccine is recommended from three months after completion of chemotherapy: hexavalent vaccine (Hib-conjugate [Hib], diphtheria/tetanus/acellular pertussis [DTaP], inactivated poliovirus [IPV] and Hepatitis B [HepB]), meningococcal B (Men B), meningococcal ACWY-conjugate (Men ACWY), 20-valent pneumococcal-conjugate (PCV20), nonavalent HPV (HPV-9), and Measles-Mumps-Rubella-Varicella (MMRV). There are no published data on immunogenicity of HPV vaccine in patients treated with standard dose chemotherapy. Our recommendation for HPV vaccine naïve patients is two doses of HPV-9 vaccine, given at 0 and 4-6 months from starting vaccination and for those that completed the course prior to diagnosis, one booster HPV-9 vaccine dose should be given.
The BCG vaccine should only be considered for those considered at high risk of tuberculosis (this should be in discussion with infectious disease specialist).

In summary, vaccination during treatment should be avoided during the period that the patient is receiving intensive chemotherapy and/ or steroids (as the immune response will be suboptimal) or when the patient is neutropenic (neutrophil count ≤$0.5x10^9$/L), but otherwise all routine non-live vaccines should be considered according to the childhood vaccination programme. In season, SIIV and SARS-COV-2 vaccines (guided by national recommendation at the time of vaccination) should be offered during treatment and within three months of completion of treatment; after this live attenuated influenza vaccine (LAIV) can be offered (for those eligible). A booster dose of all routine childhood vaccinations should be offered from three months after completion of treatment (Table 1). MMRV is a live vaccine, there is little data on the risk of vaccine-virus transmission. With recent resurgence of measles cases in the UK, we recommend MMRV vaccine at/ from three months after COT. However, clinician can decide on case-by-case basis regarding the timing (at three months after COT with the other vaccinations or a later time point after COT).
Subsequent routine booster vaccine doses will not be necessary if scheduled to be given within one year. If the patient has not received a full national vaccination schedule prior to diagnosis and treatment, then complete the vaccination schedule.

5.4 Vaccination of household members/ close contacts of patients receiving standard-dose chemotherapy (or within 3-6 months of completion)

To protect patients from VPD, household members/ close contacts (such as siblings/ parents/ grand-parents) should be encouraged to receive all age-appropriate vaccinations as per the national vaccination schedule. They should also be encouraged to receive seasonal influenza and Covid-19 vaccines. Live vaccines can be administered to household members/ close contacts of patients on chemotherapy or within 3-6 months following completion of chemotherapy (and afterwards), with particular focus on the following vaccines:

- MMRV Vaccine should be given as per the national vaccination schedule. Transmission of attenuated varicella vaccine virus from vaccinee to immunocompromised close contact has been documented, but the risk is low. Should the vaccinee develop a localised varicella like rash (usually within one month of vaccination), the rash should be covered and as a precautionary measure, the patient should avoid direct contact with the vaccinee/ their rash until the rash is dry and crusted. If the rash is disseminated, the risk of transmission is higher, and varicella prophylaxis should be provided for the immunocompromised contact as per the national guidline on post-exposure prophylaxis (PEP) for varicella or shingles, July 2025 (https://www.gov.uk/government/publications/post-exposure-prophylaxis-for-chickenpox-and-shingles/guidelines-on-post-exposure-prophylaxis-pep-for-varicella-or-shingles-january-2023#sectiond).

- Live attenuated influenza vaccine (LAIV): Household contacts that are eligible for LAIV should receive this; other household contacts should be offered SIIV. There is a theoretical potential for transmission of attenuated vaccine influenza virus from vaccinee to immunocompromised close contact for one to two weeks following vaccination so assess each individual case.

- Rotavirus vaccine: Is given to infants aged 6-24 weeks; it should not be given to the patient but can be given to siblings. There is potential for transmission from the vaccinee to immunocompromised contacts through the faecal-oral route for at least 14 days post-vaccination. However, vaccination of the infant will offer protection to household contacts from wild-type rotavirus disease and outweigh any risk from transmission of vaccine virus to immunocompromised close contacts. Good hygiene should be advised following administration.

Table 1: Vaccination schedule after completion of standard-dose chemotherapy

Time after Completion of Treatment	Pathogen protected against	Vaccine
From 3 Months	Seasonal Influenza (SIIV during first 3 months after COT)	LAIV *(live vaccine)*
	SARS-CoV-2	SARS-CoV-2 vaccine (per national guidance)
	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B	DTaP/IPV/Hib/HepB
	Meningococcal B	Men B
	Streptococcus pneumoniae	PCV20
	Meningococcal ACWY	Men ACWY-conjugate
	Measles, Mumps, Rubella, Varicella	MMRV[1] *(live vaccine)*
	Human Papillomavirus	HPV-9[2]

Vaccines: DTaP = Diphtheria/ Tetanus/ acellular Pertussis, Hib = H. influenzae b conjugate, HepB = Hepatitis B, HPV-9 = 9-valent Human papillomavirus vaccine, IPV = Inactivated polio virus, LAIV = Live attenuated influenza vaccine, Men B = Meningococcal B, Men ACWY = Meningococcal ACWY conjugate, MMRV = Measles/Mumps/Rubella/Varicella, PCV20 = 20-valent Pneumococcal conjugate, SIIV = Seasonal inactivated influenza vaccine

If PCV20 vaccine is not available, offer PCV13 (13-valent Pneumococcal conjugate vaccine).

[1] If no MMR or one MMR vaccine dose prior to diagnosis, then give two doses of MMRV vaccine.
If completed two doses MMR vaccine prior to diagnosis, then 1 x MMR and 2 x V components required so give two doses MMRV vaccine. Minimum four weeks interval between MMRV vaccine doses.
[2] HPV-9 vaccine should be offered to girls and boys ≥12 years old: For HPV vaccine naïve, two doses of HPV-9 vaccine should be given at 0 and 4-6 months from starting vaccination. For girls and boys that completed the course prior to diagnosis, a single dose should be given.

6. Vaccinations for Haemopoietic Stem Cell Transplant (HSCT) Recipients

6.1 Background

HSCT recipients are profoundly immunocompromised for months, even years, after transplant. This places them at increased risk of morbidity and mortality from infectious diseases. The components of the new immune system develop and mature at different stages; immune reconstitution after autologous HSCT occurs faster than after allogeneic HSCT. Innate immune function recovers earlier than adaptive immune function, within weeks to months after transplant. Prolonged immune deficiency arises from a deficiency of the more specialised functions of the adaptive immune system, particularly the reconstitution of T-lymphocytes (particularly CD4 lymphocytes). B-lymphocytes reach age-matched levels 3 to 6 months after transplant. Immunoglobulin isotypes start normalising 6 months after transplant in accordance with the sequence seen in normal immune ontogeny. Whilst total IgG levels may be normal, IgG subclass imbalance with low IgG2 levels can remain for 18 months or more after transplant. Antibody responses to previously encountered antigens can be elicited from 3 to 6 months after transplant. T-lymphocyte reconstitution occurs in two stages: first the thymus-independent pathway, followed by the thymus-dependent pathway. During the first 6 months after transplant, T-lymphocytes are predominantly repopulated through peripheral expansion of mature T-lymphocytes, with recovery starting 1 to 2 months after transplant and peaking at 3 to 6 months. This pathway is responsible for the rapid reconstitution of memory T-lymphocytes which are of limited repertoire diversity. At 6 to 12 months after transplant the generation of naïve T-lymphocytes is evident. Knowledge of the sequence of immune reconstitution guides the timing of re-vaccination after HSCT.

HSCT recipients are at increased risk of invasive infection, particularly with polysaccharide encapsulated bacteria such as *Streptococcus pneumoniae, Haemophilus influenzae*, and *Neisseria meningitidis*. This increased susceptibility is related to a number of host factors: functional hyposplenia, low serum IgG2 levels, and impaired opsonisation by specific antibodies. Therefore, it is paramount that vaccinations against these VPD are included in the re-vaccination schedule.

6.2 Vaccination schedule for haematopoietic stem cell transplant recipients

Studies have shown that HSCT recipients lose immunity from previous vaccinations and natural disease and are therefore vulnerable to VPD, particularly in the first year after transplant. Re-vaccination is essential to restore this immunity. HSCT recipients should be considered 'never vaccinated' and should be offered re-vaccination with the full national childhood vaccination schedule with some adjustments in view of their increased susceptibility to certain VPD.

Several factors influence antibody levels to previous vaccinations and immunogenicity of vaccines post-HSCT: autologous or allogeneic HSCT, time after HSCT, graft versus host disease (GvHD), treatment of GvHD with immunosuppressive agents, recipient age, the number of vaccine doses, and donor vaccination status.

International and national re-vaccination guidelines for HSCT recipients (based on a combination of expert opinion and published data) recommend that HSCT recipients should receive all primary routine childhood vaccines, together with annual SIIV vaccine.

In view of the difficulty in predicting the extent of immune compromise and immune reconstitution, a pragmatic approach is to recommend re-vaccination schedule for all recipients of allogeneic and

autologous HSCT.

HSCT recipients are particularly at high risk of invasive pneumococcal disease. Hence, we recommend a primary three dose course given monthly of a pneumococcal conjugate vaccine (ideally 20-valent pneumococcal conjugate vaccine, PCV20) commencing from six months post-HSCT, followed by a booster dose after a further ten months. The recommended booster is a further dose of PCV20.

HSCT recipients need to be protected against meningococcal disease. There are currently no data on immunogenicity of MenB vaccines in HSCT recipients. The immunogenicity of a single dose of MenACWY conjugate vaccine is poor in HSCT recipients but is improved with a second dose. Therefore, we recommend following the routine national vaccination schedule for the MenB vaccine, and two doses of MenACWY vaccine in HSCT recipients.

There are limited data on the safety of BCG vaccines in HSCT recipients and current international guidance is that BCG vaccine is contraindicated in HSCT recipients and therefore administration is not recommended.

In summary, HSCT recipients should be considered never vaccinated and the aim is to commence re-vaccination as soon as it is safe and a protective immune response can be reliably achieved. The routine use of markers of immune reconstitution to guide timing of vaccination is not recommended. However, this can be decided on case-by-case basis by the transplant team. Re-vaccination from six months post-HSCT is recommended provided there are no contraindications or reasons to defer vaccination (transplant team can decide on case-by-case basis to balance risk of VPD, and immunogenicity and safety of vaccination). Some non-live vaccines may be given at an earlier time point depending on the individual's circumstances and risk of infection. Given the risk of attenuated vaccine virus disease, live vaccines should be avoided until 24 months post-HSCT.

The vaccines recommended and their timing post-HSCT are detailed in Table 2.

6.3 General Principles for Re-vaccination of HSCT recipients

Re-Vaccination should commence:

- From 6 months after HSCT (transplant team can review this on case-by-case basis)
- Off all immunosuppressive treatment, ideally for at least 6 months, but non-live vaccines may be given earlier depending on the individual's circumstances and risk of VPD

Criteria for administration of live vaccines:

- 24 months post HSCT
- No active GvHD
- No immunosuppressive therapy for 12 months
- No intravenous immunoglobulin (IVIg) in last 3 months

6.4 Vaccinations for Household members/ Close Contacts of HSCT recipients

To protect HSCT recipients from VPD, household members/ close contacts (such as siblings/ parents/ grand-parents) should be encouraged to receive seasonal influenza vaccines and all age-appropriate vaccinations as per the national vaccination schedule, with the following caveats:

- MMRV Vaccine should be given as per the national vaccination schedule. Transmission of attenuated varicella vaccine virus from vaccinee to immunocompromised close contact has been documented, but the risk is low. Should the vaccinee develop a localised varicella like rash (usually within one month of vaccination), the rash should be covered and as a precautionary measure, the patient should avoid direct contact with the vaccinee/ their rash until the rash is dry and crusted. If the rash is disseminated, the risk of transmission is higher, and varicella prophylaxis should be provided for the HSCT recipient as per the national guidline on post-exposure prophylaxis (PEP) for varicella or shingles, July 2025 (https://www.gov.uk/government/publications/post-exposure-prophylaxis-for-chickenpox-and-shingles/guidelines-on-post-exposure-prophylaxis-pep-for-varicella-or-shingles-january-2023#sectiond).

- Live attenuated influenza vaccine (LAIV): There is a theoretical potential for transmission of live attenuated influenza virus from vaccinee to immunocompromised contact for one to two weeks following vaccination. LAIV should not be administered to eligible household members of HSCT recipients within two months of transplant or if the HSCT-recipient has active GvHD. During this period, they and other household members/ close contacts should be offered SIIV.
- Avoid Rotavirus vaccine in household members/ close contacts within two months of transplant or if the HSCT recipient has active GvHD.

Table 2: Re-Vaccination Schedule for HSCT Recipients

Time post-HSCT	Pathogens Protected Against	Vaccine
Annually from 6 months (consider from 3 months if peak transmission period)	Seasonal Influenza SARS-CoV-2	SIIV SARS-CoV-2 vaccine (as per national guidance)
6 months	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B Meningococcal B *Streptococcus pneumoniae* Human Papillomavirus[1]	DTaP/IPV/Hib/HepB (dose 1) MenB (dose 1) PCV20 (dose 1) HPV-9 (dose 1)
7 months	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B Meningococcal B *Streptococcus pneumoniae* Human Papillomavirus	DTaP/IPV/Hib/HepB (dose 2) MenB (dose 2) PCV20 (dose 2) HPV-9 (dose 2)
8 months	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B Meningococcal ACWY[2] *Streptococcus pneumoniae*	DTaP/IPV/Hib/HepB (dose 3) Men ACWY (dose 1) PCV20 (dose 3)
12 months	Human Papillomavirus	HPV-9 (dose 3)
18 months	Meningococcal ACWY [2] Meningococcal B *Streptococcus pneumoniae* *Haemophilus influenzae* b	Men ACWY (dose 2) MenB (Booster dose) PCV20 (Booster dose) DTaP/IPV/Hib/HepB
24 months	Measles, Mumps, Rubella, Varicella [3,4]	MMRV (dose 1) *live vaccine*
30 months	Measles, Mumps, Rubella, Varicella	MMRV (dose 2) *live vaccine*
3 years	Diphtheria, tetanus, pertussis polio	DTaP/IPV
14 years	Diphtheria tetanus, polio	Td/IPV

Vaccines: DTaP = Diphtheria/ Tetanus/ acellular Pertussis, dT = Low dose diphtheria/ Tetanus, Hib = *H. influenzae b* conjugate, HepB = Hepatitis B, HPV-9 = 9-valent Human papillomavirus vaccine, IPV = Inactivated polio virus vaccine, Men B = Meningococcal B, Men ACWY = Meningococcal ACWY conjugate, MMRV = Measles/Mumps/Rubella/Varicella, PCV20 = 20-valent Pneumococcal conjugate vaccine, SIIV = Seasonal inactivated influenza vaccine
If PCV20 vaccine is not available, offer PCV13 (13-valent Pneumococcal conjugate vaccine)

[1]HPV-9 vaccine, for patients aged >12 years, Three dose schedule is recommended for immunocompromised patients, two doses with one month interval and then a third dose 4-6 months after the first dose.
[2] HSCT Patients at risk from meningococcal disease therefore first dose of quadrivalent conjugate vaccine recommended at 8 months post HSCT.
[3] Criteria for administration of live vaccines. i) 24 months post HSCT ii) No active GvHD iii) No Immune suppressive therapy for 12 months iv) No IVIg in last 3 months. [4] If criteria for live vaccines met can consider vaccinating from 18 months post HSCT if community outbreak of Measles. Minimum four weeks interval between MMRV doses.

7. Implementation

7.1 Barriers and Facilitators

Barriers:

- Clinician and CYP/ carer hesitancy about the vaccination schedules and timing of vaccine administration.
- The reluctance/ hesitancy of primary care to administer vaccines that are outside the national vaccination schedule.
- Due to lack of data, we recommend two doses of HPV-9 vaccine in HPV vaccine naïve CYP after completion of standard-dose chemotherapy; primary care hesitancy to administer because the national recommendation is one HPV-9 vaccine dose for non-immunocompromised CYP.

Facilitators: The main facilitator for the clinical implementation of this guideline is the CYP's PTC and/or POSCU clinician recommending vaccinations for CYP treated for cancer; providing a copy of the vaccination schedule for the CYP/ their carer and primary care will promote this.

7.2 Audit Measures

The following key areas of recommendation will be audited:

- CYP treated with standard dose chemotherapy are recommended and offered vaccinations from three months after completion of treatment.
- CYP on standard dose chemotherapy are recommended and offered annual SIIV.
- HSCT recipients are recommended and offered vaccination from six months after HSCT (providing set criteria for initiation of re-vaccination fulfilled).
- HSCT recipients are recommended and offered annual SIIV.

7.3 Research Recommendations

The GDG identified areas where there is further research required:

1. There are not any published studies on immunogenicity of less than three HPV vaccine doses in CYP treated for cancer:

    - To compare a one dose HPV-9 vaccine schedule (reduced dose schedule) to a two dose HPV-9 vaccine schedule (current dose schedule) in CYP treated with standard-dose chemotherapy (for haematological and solid cancers). Randomised, open-label study. Compare the immunogenicity of the two vaccination schedules by measuring anti-HPV serotype specific antibody levels (the presence of anti-HPV antibody level is 'indicative' of protection).
    - To compare a one dose and two dose HPV-9 vaccine schedules (reduced dose schedules) to three dose HPV-9 vaccine schedule (current dose schedule) in CYP treated with HSCT. Randomised, open-label study.

2. Immunogenicity (and safety) of MMRV vaccine administered at time points (as per guideline) after completion of standard-dose chemotherapy and after HSCT.
3. Immunogenicity of Meningococcal B vaccine administered at time points (as per guideline) after completion of standard-dose chemotherapy and after HSCT.

4. Immunogenicity of PCV20 vaccine administered at time points (as per guideline) after completion of standard-dose chemotherapy and after HSCT.
5.Surveillance data for LAIV associated influenza infection when accidently administered to CYP on standard dose chemotherapy or within three months of completion of chemotherapy.

7.4 Lay summary

Children and young people (CYP) treated for cancer have a weakened immune system secondary to their treatment. They also lose previously acquired immunity (protection) from vaccinations after they complete chemotherapy, and more so after bone marrow transplant (also known as haematopoietic stem cell transplant, HSCT). This places them at increased risk of serious infections that can require admission to hospital. To protect CYP treated for cancer from vaccine preventable infections, they should be offered select non-live vaccines during treatment, and then booster vaccinations from three months after completion of standard-dose chemotherapy and a full re-vaccination programme from six months after HSCT (guided by their medical team). Live vaccines such as MMRV, rotavirus vaccine and LAIV should not be given during treatment and for a period after treatment that the CYP is considered immunocompromised (due to the risk of vaccine related infection).
This guideline has been produced using the current evidence base and existing guidelines aligned with the UK national vaccination schedule to recommend a standardised vaccination schedule for CYP treated for cancer with standard dose chemotherapy and with HSCT. Where published evidence is not available, we have based recommendations on expert consensus.
This guideline also provides guidance about vaccinations for household members/ close contacts, as a means to protect the CYP with cancer against vaccine preventable infections.
We strongly recommend vaccination for children and young people treated for cancer; and this should be promoted by their managing medical team.

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9. Appendices

Appendix 1: Vaccination schedule after Completion of Standard-dose Chemotherapy

Patient Name and DOB:

Date Vaccinations due from:

Time after Completion of Treatment	**Pathogen protected against**	**Vaccine**	**Trade Name** (Equivalent alternative may be used)
From 3 Months	Seasonal Influenza (SIIV during first 3 months after COT)	LAIV (*live vaccine)*	Various
	SARS-CoV-2	SARS-CoV-2 vaccine (per national guidance)	Various
	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B	DTaP/IPV/Hib/HepB	Infanrix hexa or Vaxelis
	Meningococcal B	Men B	Bexsero
	Streptococcus pneumoniae	PCV20	Prevenar20
	Meningococcal ACWY	Men ACWY-conjugate	Nimenrix or Menveo
	Measles, Mumps, Rubella, Varicella	MMRV[1] *(live vaccine)*	ProQuad or Priorix-Tetra
	Human Papillomavirus	HPV-9[2]	Gardasil 9

Vaccines: DTaP = Diphtheria/ Tetanus/ acellular Pertussis, Hib = H. influenzae b conjugate, HepB =Hepatitis B, HPV-9 = 9-valent Human papillomavirus vaccine, IPV = Inactivated polio virus, LAIV = Live attenuated influenza vaccine, Men B = Meningococcal B, Men ACWY = Meningococcal ACWY conjugate, MMRV = Measles/Mumps/Rubella/Varicella, PCV20 = 20-valent Pneumococcal conjugate, PCV13 = 13-valent Pneumococcal conjugate, SIIV = Seasonal inactivated influenza vaccine

If PCV20 vaccine is not available, offer PCV13 (13-valent Pneumococcal conjugate vaccine).

[1] If no MMR or one MMR vaccine dose prior to diagnosis, then give two doses of MMRV vaccine.
If completed two doses MMR vaccine prior to diagnosis, then 1 x MMR and 2 x V components required so give two doses MMRV vaccine. Minimum four weeks interval between MMRV doses.
[2] HPV-9 vaccine should be offered to girls and boys ≥12 years old: For HPV vaccine naïve, two doses of HPV vaccine should be given at 0 and 4-6 months from starting vaccination. For girls and boys that completed the course prior to diagnosis, a booster dose should be given.

If the named vaccine is not available, an alternative with the same composition may be used.
Multiple inactivated and live vaccines can be co-administered preferably at different sites.

For more information, please look at the full vaccination guideline on the CCLG website - https://www.cclg.org.uk

Appendix 2: Vaccination Schedule for Haematopoietic Stem Cell Transplant Recipients

Patient Name and DOB:
Date Vaccinations due from:

Time post-HSCT	**Pathogens Protected Against**	**Vaccine**	**Trade Name** (Equivalent alternative may be used)
Annually from 6 months (consider from 3 months if peak transmission period)	Seasonal Influenza SARS-C0V-2	SIIV SARS-C0V-2 vaccine (as per national recommendations)	Various Various
6 months	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B Meningococcal B *Streptococcus pneumoniae* Human Papillomavirus[1]	DTaP/IPV/Hib/HepB (dose 1) MenB (dose 1) PCV20 (dose 1) HPV-9 (dose 1)	Infanrix hexa or Vaxelis Bexsero Prevenar20 Gardasil 9
7 months	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B Meningococcal B *Streptococcus pneumoniae* Human Papillomavirus	DTaP/IPV/Hib/HepB (dose 2) MenB (dose 2) PCV20 (dose 2) HPV-9 (dose 2)	Infanrix hexa or Vaxelis Bexsero Prevenar20 Gardasil 9
8 months	Diphtheria, tetanus, pertussis, polio, *Haemophilus influenzae* b, Hepatitis B Meningococcal ACWY[2] *Streptococcus pneumoniae*	DTaP/IPV/Hib/HepB (dose 3) Men ACWY (dose 1) PCV20 (dose 3)	Infanrix hexa or Vaxelis Nimenrix or Menveo Prevenar20
12 months	Human Papillomavirus	HPV-9 (dose 3)	Gardasil 9
18 months	Meningococcal ACWY [2] Meningococcal B *Streptococcus pneumoniae* *Haemophilus influenzae* b	Men ACWY (dose 2) MenB (Booster dose) PCV20 (Booster dose) DTaP/IPV/Hib/HepB	Nimenrix or Menveo Bexsero Prevenar20 Infanrix hexa or Vaxelis
24 months	Measles, Mumps, Rubella, Varicella [3,4]	MMRV (dose 1) *live vaccine*	ProQuad or Priorix-Tetra
30 months	Measles, Mumps, Rubella, Varicella	MMRV (dose 2) *live vaccine*	ProQuad or Priorix-Tetra
3 years	Diphtheria, tetanus, pertussis polio	DTaP/IPV	Repevax or Boostrix IPV
14 years	Diphtheria tetanus, polio	Td/IPV	Revaxis

Vaccines: DTaP = Diphtheria/ Tetanus/ acellular Pertussis, dT = Low dose diphtheria/ Tetanus, Hib = *H.influenzae b* conjugate, HepB = Hepatitis B, HPV-9 = 9-valent Human papillomavirus vaccine, IPV = Inactivated polio virus, Men B = Meningococcal B, Men ACWY = Meningococcal ACWY conjugate, MMRV = Measles/Mumps/Rubella/Varicella, PCV20 = 20-valent Puneumococcal conjugate vaccine, SIIV = Seasonal inactivated influenza vaccine
If PCV20 vaccine is not available, offer PCV13 (13-valent Pneumococcal conjugate vaccine).
[1]HPV-9 vaccine, For patients aged >12 years, Three dose schedule is recommended for immunocompromised patients, two doses with one month interval and then a third dose 4-6 months after the first dose.
[2] HSCT Patients at risk from meningococcal disease (and have poor immune response to one vaccine dose) therefore two doses of quadrivalent conjugate vaccine recommended, with first dose at 8 months post HSCT.
[3] Criteria for administration of live vaccines. i) 24 months post HSCT ii) No active GvHD iii) No Immune suppressive therapy for 12 months iv) No IVIg in last 3 months. [4] If criteria for live vaccines met can consider vaccinating from 18 months post HSCT (especially if community outbreak of Measles). Minimum four weeks interval between MMRV doses.

Multiple inactivated and live vaccines can be co-administered, preferably at different sites.

For more information, please look at the full vaccination guideline on the CCLG website - https://www.cclg.org.uk

Appendix 3: Search Strategies and Selection Criteria

This guideline was first published over 15 years ago. The search strategy for this version has included evidence available since the last update.

Population	AND
Vaccination: general	AND
Routine Vaccines	AND
Common other vaccines	AND
Additional vaccines	AND
Time period you wish to be covered	1990 - 2026

Search terms

Population

Cancer, chemotherapy, HSCT

Vaccination

Vaccin* OR immunis*

Vaccines

- Diphtheria: Diphtheria
- Tetanus: Tetanus
- Whooping cough: Whooping cough OR pertussis,
- Polio: polio
- Hib: *Haemophilus influenzae* b OR Hib
- Hep B: Hepatitis B OR hep B
- PCV13: *Streptococcus pneumoniae* or pneumococc*
- Men C: Men*C,
- Men B: meningococcus B OR men B
- Men ACWY: meningococcus ACWY OR men ACWY
- Rotavirus: Rotavirus
- MMR: Measles OR mumps OR rubella OR german measles
- Flu: Influenza OR flu
- Human papilloma virus: Human papilloma virus or HPV
- Varicella: Varicella OR chicken pox
- BCG: Tuberculosis OR TB OR BCG