Guidelines for the public health management of Measles in Ireland

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Please note that this document should be used in tandem with other relevant documentation available on Health Protection Surveillance Centre; https://www.hpsc.ie/a-z/vaccinepreventable/measles/guidance/

Readers should not rely solely on the information contained within these guidelines. Guidance information is not intended to be a substitute for advice from other relevant sources including, but not limited to, the advice from a health professional. Clinical judgement and discretion will be required in the interpretation and application of this guidance. This guidance will be updated based upon emerging evidence at national and international levels and national policy decisions.

For further information please contact rgdu@hpsc.ie

Contents

Glossary of acronyms and abbreviations

ADPHs	Area Directors of Public Health
AIDs	Acquired Immune Deficiency Syndrome
ALL	Acute Lymphoblastic Leukaemia
AMRIC	Antimicrobial Resistance and Infection Control
BOTP	Beneficiary of Temporary Protection (fleeing war in Ukraine)
CBR	Consensus Based Recommendations
CHW/TCHW	Community Health Workers/Traveller Community Health Worker
CIDR	Computerised Infectious Disease Reporting
CLIA	Chemiluminescence Immunoassays
CPHM	Consultant in Public Health Medicine
DCEDIY	Department of Children, Equality, Disability, Integration and Youth
DFA	Direct Fluorescent Antibody
DPH	Departments of Public Health
ED	Emergency Department
EDTA	Ethylenediamine Tetraacetic acid
EIA	Enzyme Immunoassays
ESF	Enhanced Surveillance Form
EU/EEA	European Union/European Economic Area
GDG	Guideline Development Group
GP	General Practitioner
HNIG	Human Normal Immunoglobulin
HPAC-ID	Health Protection Advisory Committee for Infectious Disease
HPRA	Health Products Regulatory Authority
HPSC	Health Protection Surveillance Centre
HSE	Health Service Executive
ICGP	Irish College of General Practitioners
IHR NFP	International Health Regulations National Focal Point
IPA	International Protection Applicant (“asylum seeker”)
IPAS	International Protection Accommodation Service Team in the DCEDIY
IPC	Infection Prevention and Control
IPS	Irish Prison Service
IRPP	Irish Refugee Protection Programme
IVIG	Intravenous Immunoglobulin
LHO	Local Health Office
MCV	Measles-containing vaccine
MMR	Measles, Mumps and Rubella

MOH	Medical Officer of Health
NAS	National Ambulance Service
NHPO	National Health Protection Office
NIAC	National Immunisation Advisory Committee
NICT	National Infection Control Team
NIDIF	HSE National Infectious Disease Isolation Facility
N-IMT	National Incident Management Team
NSIO	HSE National Social Inclusion Office
NVRL	National Virus Reference Laboratory
OCIMS	National Outbreak Case and Incident Management System
OCT	Outbreak Control Team
OF	Oral Fluid
OOH	Out of hours
PCR	Polymerase Chain Reaction
PEP	Post-Exposure Prophylaxis
PHCTPs	Primary Healthcare for Travellers Projects
PHRA	Public Health Risk Assessment
PPD	Prisons and Places of Detention
PPV	Positive Predictive Value
PSEC	Prison Service Escort Corp
RASP	Refugees and Applicants Seeking Protection
RGDU	Research and Guideline Development Unit
RNA	Ribonucleic acid
RVC	European Regional Verification Commission for Measles and Rubella Elimination
R_0	Basic Reproduction Number
SEU	Sero-epidemiology Unit
SPHM	Specialist in Public Health Medicine
SSPE	Sub-acute sclerosing panencephalitis
THU	HSE Traveller Health Units
UCD	University College Dublin
UCTAT	Ukraine Crisis Temporary Accommodation Team in the DCEDIY
UKHSA	UK Health Security Agency
WHO	World Health Organization

Preface

Introduction

Since 2023, significant increases in the number of measles cases and outbreaks have been observed globally, including in 40 of the 53 countries of the European region, and in at least ten EU/EEA countries. Measles cases are expected to continue increasing in the EU/EEA due to sub-optimal vaccination coverage for measles containing vaccines (MCV), and the high probability of importation of cases from areas experiencing high circulation. Ireland achieved World Health Organization (WHO) measles elimination status in 2017, and most cases of measles notified in Ireland in recent years have been imported cases or epidemiologically linked to an imported case (1).

Measles is highly contagious, and it is estimated that 90% of susceptible[a] people exposed to an infectious individual will contract the disease. Measles infection can result in serious illness and approximately 20% of cases will be hospitalised. Measles is a vaccine-preventable disease and MCV (MMR) is part of the childhood immunisation schedule in Ireland, given at 12 months (Dose 1) and five years of age (Dose 2). Measles, Mumps and Rubella (MMR) uptake in Ireland is suboptimal and less than the 95% target set by the WHO. Nationally, uptake has declined to below 90% since the beginning of the COVID-19 pandemic (early 2020) (2).

A national incident management team (N-IMT) for Measles was established on January 31st, 2024, in response to the increasing threat of measles from Europe. While there is up to date guidance available on measles and MMR vaccine from the National Immunisation Advisory Committee (NIAC) (3), some topic-specific measles guidance on the Health Protection Surveillance Centre (HPSC) website and some regional public health guidance, comprehensive national measles guidelines are not available. Therefore, the Measles N-IMT proposed that a Guideline Development Group (GDG) be convened within the National Health Protection Office (NHPO) to work in collaboration with the Research and Guideline Development Unit (RGDU) to produce National Measles Guidelines for Ireland.

Purpose

These guidelines provide detailed public health advice on the prevention and management of cases and contacts of measles in Ireland. The purpose of these guidelines is to provide nationally consistent

[a] A person should be considered susceptible if they have not received two doses of MMR vaccine or do not have serological evidence of measles immunity (i.e., detectable measles specific IgG from an INAB accredited laboratory or equivalent)

guidance to regional Departments of Public Health (DPH) in responding to a notifiable disease event. This document provides detailed public health guidance on the risk assessment of suspected measles cases, the management of their contacts and a description of the laboratory testing services available to support this. This guideline has been adapted from the 2024 UKHSA National Measles Guidelines (4).

This guideline review was undertaken by a multidisciplinary guideline development group convened by HSE Public Health: NHPO in 2024 following the upsurge of measles cases in Ireland (please see **Appendix 1** for membership). and should be considered in conjunction with other relevant HSE Public Health: NHPO guidance and algorithms for the public health management of measles available **here**.

Acknowledgements

The NHPO is grateful for the contributions that many individuals and organisations have made to the development of this guideline. A full list of guideline development group members and external stakeholders involved in the development of this guideline are outlined in **Appendix 1.**

Methodology

This guideline has been adapted from UKHSA National Measles Guidelines following a comprehensive search and appraisal of international guidelines (5). The methodology applied to adapt the UKHSA guideline was based primarily on Consensus Based Recommendations (CBR) as per the Framework for the development of National Health Protection Guidance in Ireland. This methodology is used to assist practitioners when developing public health guidance and where reaching expert consensus is needed to determine the applicability, acceptability and feasibility of the recommendations from the source guideline.

Consensus methods require a group or panel of experts, the GDG, to review existing evidence (or the evidence on which the source guideline is based), the interpretation of that evidence in the local context and agree on recommendations. Each chapter within the guideline was reviewed by content experts from across Ireland with expertise in the specific topic. The appointed chair of the group acted as facilitator of the consensus process. Criteria for the 'consensus process working group' membership included:

- extensive in-depth knowledge and experience of the topic in question

- no existing conflict of interest that would prohibit ability to make a balanced judgement relating to the topic in question.

The GDG considered the selected evidence available (scientific and/or non-scientific) and interpreted this to adequately address the proposed key guideline. Modifications to source recommendations and the evidence supporting the modification were carefully documented. A formal approach was adopted to reach consensus on recommendations by combining a modified e-Delphi approach (6) and the Nominal Group Technique (7). The GDG documented the decision-making process and how they moved from the available evidence to each recommendation. Recommendations were either accepted, accepted with modifications or rejected. Based on these decisions the panel created an adapted guideline acceptable for the context that addresses the health questions.

Review and approval process

Each chapter underwent extensive review; all chapters were reviewed by the Chair of the GDG, and at least one other Chapter Lead. Each chapter was presented to the GDG for input. Following input by all members of the GDG, each chapter was revised by the Chapter Lead and members of the specific chapter groups. Subsequent revised versions were circulated to the GDG members for approval.

Approved versions were then sent for external review by experts in the topic. All chapters were reviewed by members of N-IMT for measles and the Area Directors of Public Health. All feedback and subsequent revisions were reviewed by the Chair of the GDG. Upon acceptance, the GDG recommended approval of the guideline to the Health Protection Advisory Committee for Infectious Disease (HPAC-ID) and the Director of National Health Protection.

In advance of publication of the Guidelines the GDG engaged with the National Patient and Service User Forum and a final draft copy was made available. This was completed in February 2025.

Future updates

A review of this guideline will be undertaken no more than three years after publication by the Research and Guideline Development Unit (RGDU) as part of the routine cycle of guideline review. The RGDU may undertake a more rapid update of specific chapters within this guideline if new and relevant evidence is published according to need.

Disclosure Statement

The subject matter expert group members were asked to declare potential conflicts of interest at the time of appointment. A policy for the management of conflict of interest was put in place.

Funding

The RGDU was commissioned by the Measles N-IMT to undertake the work on this guideline. No funding was received for the development of this guideline.

Chapter 1 Background

1. Background

1.1 Introduction

Measles is a highly infectious virus, and the most infectious of all diseases transmitted through the respiratory route. Measles can be severe, particularly in immunocompromised individuals and young infants. It is also more severe in pregnancy, and increases the risk of miscarriage, stillbirth, or preterm delivery (8). The most effective way to control measles is by achieving high uptake of two doses of measles, mumps, and rubella (MMR) vaccine. High sustained coverage is key to achieving elimination of endemic measles.

Measles vaccine effectiveness

Approximately 95-98% of recipients develop immunity to measles after one dose of the MMR vaccine (MMR1). Over 99% of those who receive two doses of measles vaccine (MMR2) ≥12 months of age and ≥4 weeks apart will develop measles immunity, which is lifelong in most people (2). Breakthrough infections are uncommon and are generally milder than in unvaccinated persons. Lower rates of seroconversion occur in those vaccinated under 12 months of age, because of trans-placental maternal antibodies.

Measles in Ireland

Following the introduction of a single antigen measles only vaccination programme in Ireland in 1985, the number of measles cases notified declined dramatically. A single dose of MMR vaccine was incorporated into the programme in 1988 and in 1992 a second MMR dose was introduced into the schedule. Measles cases declined from almost 10,000 notified cases in 1985 to 201 cases in 1987 (Figure 1). However, large outbreaks continued to occur with 4,328 cases in 1993 and 1,603 cases in 2000 (9).

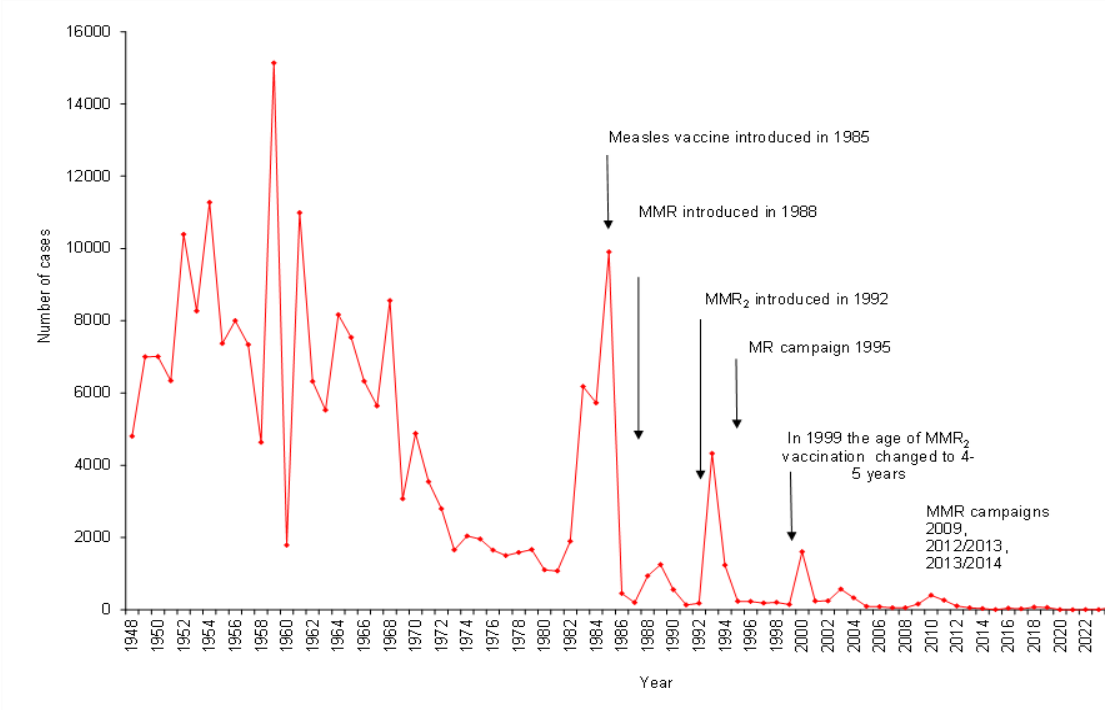

Figure 1: Annual number of measles cases in Ireland and the timeline of measles-containing vaccination programmes and catch-up campaigns, 1948-2023

*Some changes to the measles vaccine/MMR vaccine schedule are outlined in the graph above and further changes/details can be found **here**.*

A measles and rubella (MR) campaign for children aged 5-12 years was conducted in 1995

A MMR vaccination campaign started in April 2009 for students in fourth, fifth and sixth year of second level schools

A MMR catch-up campaign was conducted during the 2012/2013 and 2013/2014 academic years for children/students attending primary schools, second level schools and special schools and home-schooled students who had not completed (or were not sure they had) their two dose MMR vaccination schedule. MMR_2-second dose of MMR.

Prior to 2024, in recent years in Ireland the number of measles cases has been low, especially since the onset of the COVID-19 pandemic in 2020 (Figure 2). In September 2007, the Measles and Rubella Elimination Committee of the Department of Health published the National Measles and Rubella Elimination Strategy for Ireland, identifying, and making recommendations to address, the gaps in immunity, surveillance and control activities (9). Measles elimination is defined as the absence of endemic measles cases in a defined geographical area for a period of at least 12 months, in the presence of a well-performing surveillance system (10). Since 2007, measles elimination in Ireland has been realised (9) through: routine MMR vaccination programmes and catch-up campaigns; political and financial support and commitment of the Department of Health and the HSE; commitment and dedication of staff across the health service; improved surveillance, investigation and control by Public Health; and increased timeliness of diagnostic testing and genotyping of measles,. The European

Regional Verification Commission (RCV) for Measles and Rubella Elimination concluded at the seventh meeting of the European RVC that measles was eliminated in Ireland in 2017 (11). At the eighth-twelfth European RVC meetings, the RVC concluded that measles elimination was sustained in Ireland during 2018 to 2022 but reiterated its concerns about the threat to measles elimination due to low vaccination coverage across certain age-groups, especially in Dublin (12).

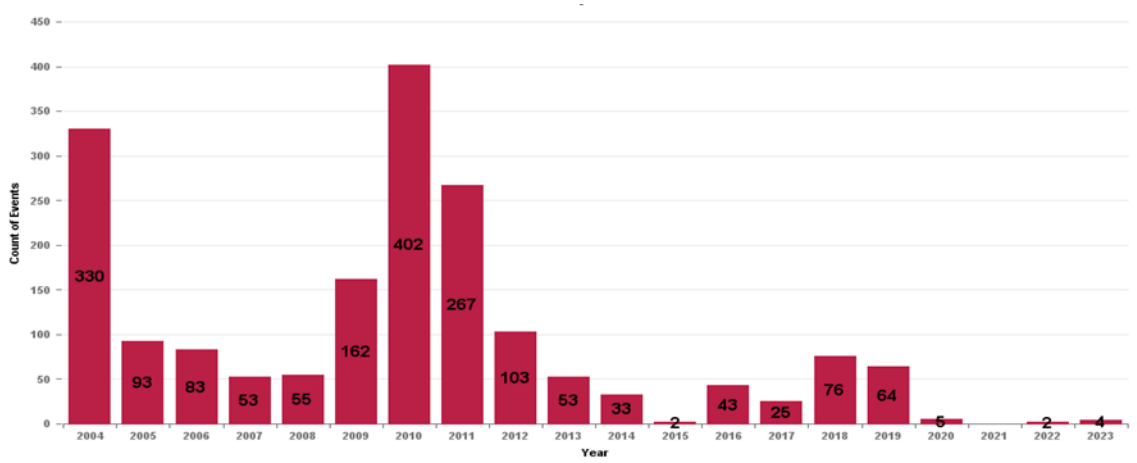

Figure 2 Annual number of measles cases notified in Ireland, 2004 – 2023

Measles susceptibility in Ireland

MMR vaccine uptake in Ireland is suboptimal and less than the 95% target set by the WHO. In Q1 2024, the MMR1 uptake nationally in Ireland was 89.3%. The national uptake of MMR1 has been below 90% for nine consecutive quarters (Figure 3). Geographical variation also exists, ranging from a low of 81.7% in Sligo/Leitrim to a high of 95.5% in Laois/Offaly in Quarter 1 2024 (Figure 4).

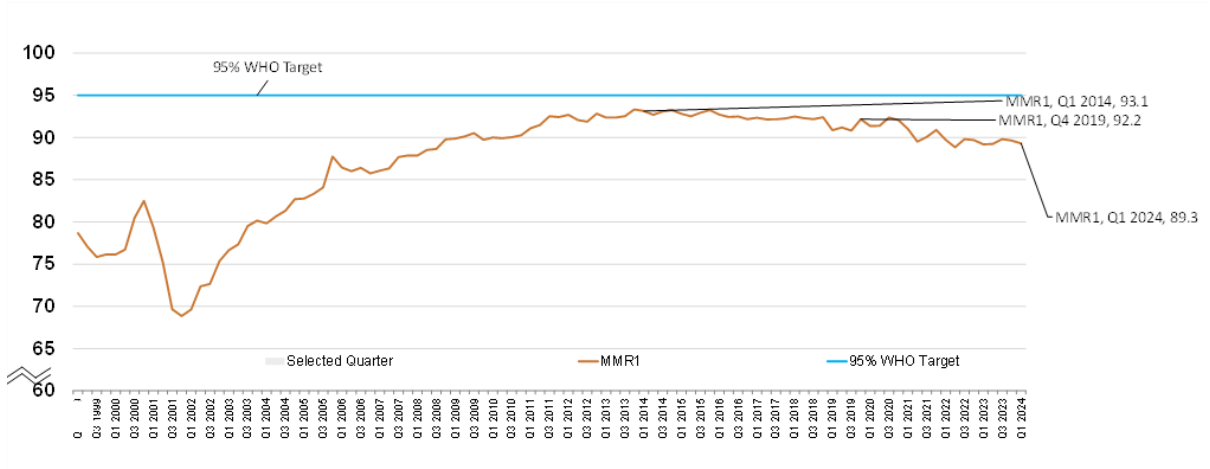

Figure 3 MMR1 uptake rates (%), in those aged 24 months by quarter, Ireland Quarter 1 1999- Quarter 1 2024

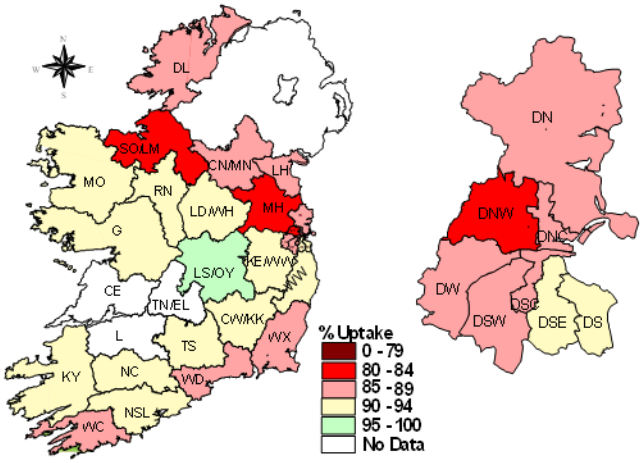

Figure 4 MMR1 immunisation uptake rates (%) by LHO, in those 24 months of age in Quarter 1-2024, in (A) Ireland and (B) Dublin

The most recent available data for MMR2 vaccine uptake is from the 2022/2023 academic school year. The MMR2 uptake in junior infants was under 90% (Figure 5): 80.4% in LHOs where GPs administer MMR2 and 89.8% in LHOs where HSE schools teams administer MMR2.

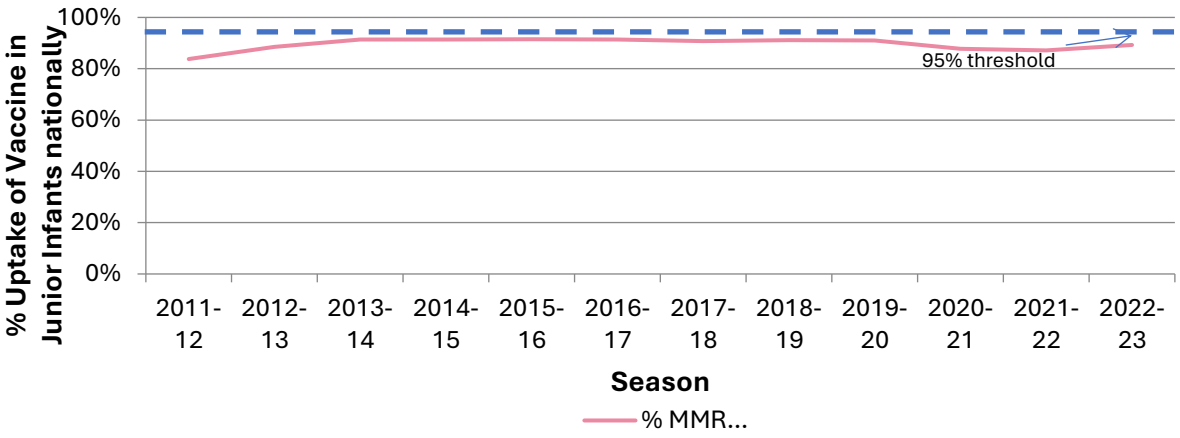

Figure 5: Estimated percentage uptake of MMR vaccines nationally in Ireland, between 2011/2012 and 2022/2023

A recent Irish measles antibody seroprevalence study estimated that 10.7% of adults aged 18-34 years may be susceptible to measles (13). The study, conducted by the Seroepidemiology Unit (SEU) in the HPSC, as part of the National Serosurveillance Programme in 2022, found that measles antibody seropositivity was lowest (82.1%) in males aged 18-19 years. The findings indicate a significant proportion of adults that are potentially susceptible to measles, particularly younger adult males (Table 1).

In addition, a paediatric measles seroprevalence study, which was planned to commence in the SEU in 2023 could not be progressed on time due to difficulty in collecting the relevant sera. The initiation of the national Measles IMT and associated communications resulted in four hospital labs around the country volunteering to provide suitable sera from children aged 3-17 years, in 2024. Sample collection and laboratory testing has now concluded. Data analysis is currently in progress, and provisional results show that measles antibody seropositivity was 90.3% overall, and it was lower among older children aged 10-17 years when compared to younger children aged 3-9 years. The full study results will be published in due course.

Table 1: Seronegative proportion, stratified by sex 2022

Age group (years)	Birth cohort	Sex	N seronegative	Total	% seronegative	CI lower	CI Upper
18-19	2003-2004	Female	22	132	12.3	6.5	20.2
		Male	22	101	17.9	10.4	27.7
20-24	1998-2002	Female	45	343	8.5	5.1	12.8
		Male	54	275	15.6	10.9	21.1
25-29	1993-1997	Female	55	351	11.3	7.5	15.8
		Male	38	286	8.7	4.9	13.5
30-34	1988-1992	Female	60	374	11.7	8.0	16.1
		Male	34	321	5.7	2.6	9.9

While vaccine coverage data is available at geographic area level (LHO), specific information on vaccine coverage among certain population groups is not available, mostly due to lack of data on ethnicity or other equity stratifiers. Therefore, we do not have an indication of measles vaccine uptake and measles susceptibility in these populations in Ireland. This includes specific underserved communities in Ireland considered at high risk of exposure to measles such as Irish Travellers and Roma, people experiencing homelessness, and vulnerable migrants such as refugees, international protection applicants (IPA) ('asylum seekers') and beneficiaries of temporary protection (BOTP) fleeing war in Ukraine. Many refugees and applicants seeking protection live in State-provided congregate accommodation settings where the risk of transmission and risk of outbreaks is greater than in the general population. Members of the Steiner Community are also considered at high risk of exposure to measles.

To maintain measles elimination status, measles surveillance needs to remain highly sensitive to detect sporadic cases and to classify cases as endemic or imported/import-related on the basis of complete epidemiology and the viral sequence information. Discarding a sufficient proportion of suspected cases is an important indicator of the sensitivity of the surveillance system and is a WHO requirement for measles elimination (14). Determining epidemiological and virological links between confirmed cases is also vital for detecting outbreaks. Outbreaks pinpoint susceptible communities where vaccination coverage is low and thus inform targeted vaccination activity. This document provides detailed information on;

- The background of measles and the laboratory testing services available (**Chapter 1**). This is set in the context of a national surveillance system which is required to support and monitor progress. towards WHO elimination targets, as outlined in the **Irish Measles and Rubella Elimination Strategy.**
- The public health management of suspected measles cases (**Chapter 2**).
- The public health management of suspected measles cases in specific settings and situations **(Chapter 3).**

1.2 Rationale for public health action

During periods of low measles incidence, the reliability of a clinical diagnosis declines, and it is therefore important that every suspected case is investigated and confirmed or excluded using appropriate laboratory methods. Good epidemiological and virological surveillance is an important element of measles control by establishing the source of sporadic cases. Laboratory testing to confirm or discard suspected cases and timely identification of chains of transmission is critical to ensure effective interventions can be targeted appropriately and initiated promptly to limit further spread. Given the limited effectiveness of most post-exposure interventions, accurate surveillance to inform this proactive strategy is a high priority.

Measles is a notifiable disease in Ireland under the Infectious Diseases Regulations 1981 (15). A medical practitioner or a clinical director of a diagnostic laboratory, on suspecting or identifying a case of the infection, is obliged to notify cases to the Medical Officer of Health (Consultant or Specialist in Public Health Medicine) for the area of residence of the patient. Additionally, measles is on the list of infectious diseases requiring immediate preliminary notification by telephone to a Medical Officer of Health. This legislative requirement means that medical practitioners should urgently notify suspected clinical cases of measles to enable immediate control measures to be put in place. Contact details for Public Health in each HSE region are available **here**. Out of hours (OOH) contact for Public Health - via National Emergency Operations Centre by phone on 999 or 112 and ask to be connected to Public Health on call.

Susceptible vulnerable contacts (such as immunocompromised individuals, infants under 12 months of age and pregnant women) should be considered for post-exposure prophylaxis (PEP) to reduce the risk of complications and to attenuate illness where possible. Refer to **Section 2.2.3** for further details.
Susceptible healthy contacts, including unimmunised children and adults, are unlikely to benefit from post-exposure vaccination, unless offered promptly (within 72 hours) following exposure.
Healthy contacts in particular healthcare workers who work with vulnerable individuals, can be a source of transmission and need urgent assessment of immune status and possible exclusion from work.
Vaccination of susceptible contacts should confer benefit against future exposures and will also provide protection against mumps and rubella infections. In outbreak settings, such as schools and other congregate settings mass vaccination of susceptible individuals may be considered to prevent tertiary transmission.

1.3 Clinical and epidemiological features of measles, and definitions

Robust measles surveillance and timely public health management rely on clinicians and public health professionals recognising measles based on a combination of clinical and epidemiological features. With the elimination of endemic measles in Ireland, physicians/clinicians are less likely to have experience of clinically diagnosing measles cases, and therefore appropriate testing of all suspected cases is essential. Before test results are available however, management of suspected cases and contacts should proceed based on a risk assessment.

This requires consideration of a range of factors including the age of the case, vaccination history, clinical presentation, and relevant epidemiological features such as local outbreaks or an epidemiological link to a confirmed case. Collecting information on possible epidemiological links is essential to making a reliable risk assessment and will contribute towards a better understanding of measles transmission in the population.

1.3.1 Epidemiological parameters

A good understanding of the transmission parameters of measles is important to undertake an appropriate public health risk assessment (PHRA). Information about the incubation period, period of infectiousness, transmission route and infectivity are summarised here:

- The **incubation period** averages 10-12 days. Time from exposure to rash onset averages 14 days (range 7-21 days).
- The **infectious period** is from four days prior to the onset of the rash to four days after the rash erupts. In the absence of a rash the period of infectiousness should be taken from 24 hours before reported prodromal symptom onset (see description of prodrome below). Immunocompromised individuals may be infectious for longer and may not display typical symptoms, and so timings should be adjusted as appropriate in consultation with the clinician(s) managing the immunosuppressive condition.
- The **transmission route** of measles is mostly airborne (droplet spread) or by direct contact with nasal or throat secretions of infected persons; much less commonly, measles may be transmitted by articles freshly soiled with nose and throat secretions (fomite spread), or through airborne transmission with no known face-to-face contact (16, 17).
- Measles is extremely infectious, with a **basic reproduction number (R_0)** estimated around 15 to 20 (that is, on average, there will be 15 to 20 individuals infected from a single case in a totally

susceptible population); the secondary attack rate is highest among close unimmunised contacts, particularly household contacts (18, 19).

1.3.2 Clinical presentation of primary measles infection

Figure six below shows the clinical course of primary measles infection and its main symptoms. The main signs and symptoms of measles include:

- The **prodrome** (before rash onset) usually lasts 2-4 days (range 1-8 days). The prodrome phase is characterised by fever, significant malaise, anorexia (loss of appetite), coryza, conjunctivitis and cough. Conjunctivitis may be accompanied by photophobia. Conjunctivitis is a more specific symptom that differentiates measles from many other causes of influenza-like illness. Respiratory symptoms are as a result of inflammation of the mucosal due to viral infection of epithelial cells.
- **Fever** is typically present and may be as high as 40ºC. Fever and other prodromal symptoms typically intensify a few days before the rash appears.
- The erythematous, maculopapular **rash** first appears behind the ears and spreads to the face, trunk and limbs over 3-4 days. The rash may become confluent in places. Time from exposure to rash onset averages 14 days (range 7-21 days). After 3-4 days, the rash begins to fade leaving a temporary brownish discolouration.
- **Koplik spots** (small red spots with white centres) may appear on the buccal mucosa near the exit of the parotid duct, from 1-2 days before to 1-2 days after the rash appears. Koplik spots are strongly associated with measles but they are difficult to identify and should not be relied upon for diagnosis. For images of a measles rash and Koplik spots, please see **here**.

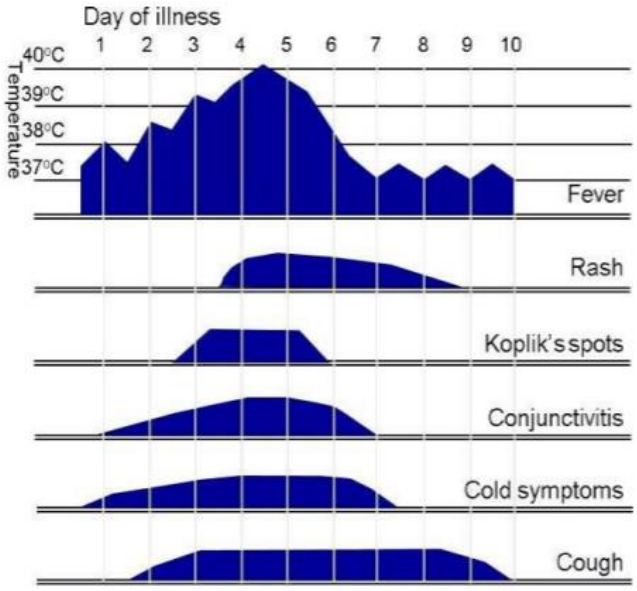

Figure 6: Clinical course of primary measles infection. Source: *WHO Manual for the laboratory diagnosis of measles and rubella infection (20).*

1.3.3 Differential Diagnoses

Several other common rash illnesses have a similar clinical presentation to measles, although the combination of rash, fever, coryzal symptoms with conjunctivitis is almost unique to primary measles infection. Rash with fever illnesses including roseola (HHV6 infection), fifth disease (parvovirus B19 infection), and scarlet fever can be indistinguishable based on clinical features alone, particularly in children, and clinical diagnosis is often unreliable. As such, the timing and nature of symptoms is often helpful in the differential diagnosis. For example, while symptoms, including fever, peak with the onset of rash in measles, in roseola, the onset of rash generally coincides with clinical improvement. A summary of the clinical features of each of these differential diagnoses is provided in **Appendix 2.**

1.3.4 Complications of primary measles infection

The most frequent complications of primary measles infection include viral pneumonitis and otitis media, as well as diarrhoea (21, 22). Measles infection often leads to a temporary reduction in immune responses in the few weeks following infection, which may increase the risk of severe secondary bacterial and viral infections (8). Young infants are at high risk of complications such as pneumonia, otitis media, SSPE, and of a fatal outcome (23).Tracheobronchitis ('measles croup') and pneumonia due to secondary bacterial infection are frequent early complications of measles (21). Encephalitis occurs more rarely, in about 0.05% to 0.1% of measles cases (24). Sub-acute sclerosing panencephalitis (SSPE), is a degenerative CNS disease presenting usually 7-10 years after infection and progressing to death, occurs in 1/25,000 infected people. If measles infection occurs in children under five years of age the rate of

SSPE is 1-3/3,000. If infection occurs in children under one year of age, the rate is 1/600, which is 16 times greater than with infection occurring over five years of age (25).

Immunocompromised individuals are at higher risk than immunocompetent individuals of developing prolonged and severe measles, and of suffering complications. Viral pneumonitis is the most frequent severe complication, which generally develops within 2 weeks of symptom onset. It is also the most common cause of death in immunocompromised individuals (21). Patients at highest risk include those who have severely impaired cell-mediated immunity, such as patients who have recently undergone bone marrow transplantation, patients with primary T-cell dysfunction, AIDS patients and patients with acute lymphoblastic leukaemia (ALL). The risk of severe disease also remains high for patients who are immunocompromised such as those with other forms of malignancy, and those receiving high doses of steroids or other types of immunosuppressive drugs. Further information about the classification of immunocompromised individuals is provided in **Chapter 2, Table 4.**

Measles can be particularly debilitating in very young infants and adults, who are more likely to develop complications and require hospitalisation. Measles can be severe in pregnant women and leads to an increased risk of prematurity and foetal loss, although there is no evidence that it leads to congenital defects (26).

1.3.5 Transmission of primary measles

Note: *In this section the term 'exposure' refers to 'significant' exposure.*

Transmission of measles is airborne via droplet spread. It is spread by coughing and sneezing, close personal contact, or direct contact with infected nasal or throat secretions. The virus remains active and contagious in the air or on infected surfaces for up to two hours.
Close prolonged interpersonal contact, e.g. household settings, may also lead to a higher infectious dose of virus, which increases both the risk of transmission and the risk of developing more severe disease (21).

Exposure to measles is considered significant if: a susceptible individual is exposed to a confirmed or probable case of measles during the infectious period (four days before to four days after the rash erupts) in any of the following ways:

- Face-to-face contact of any duration
- An immunocompetent individual is in a room with the case for more than 15 minutes. This includes those who may have been exposed to measles in the setting of an emergency department or an outpatient clinic where the intensity of such exposure cannot accurately be judged

- An immunocompromised person is in a room with the case for any duration or enters a room vacated by a case within two hours of the case leaving the room.
- In-utero exposure to maternal measles where maternal measles rash occurs within six days before to six days after birth.

Groups at increased risk for severe illness and complications include:

- Infants younger than 12 months of age
- Pregnant women
- Those who are immunocompromised (see **NIAC Immunisation Guidelines Chapter 3 Immunisation of Immunocompromised Persons)** (27).

Household contacts of a case have higher intensity exposure and an **increased** risk of more severe disease than non-household contacts.
Appropriate measures for triage and isolation in health care settings are essential to avoid prolonged exposure to suspected measles cases in waiting areas. In a recent series of cases associated with transmission in health care settings, 5 of the 7 secondary cases were in the same room as the index case for between 2.5 and 4 hours (28).

1.3.6 Breakthrough measles (reinfection)

The term 'breakthrough measles' (previously referred to as 'reinfection', or secondary vaccine failure) is used to describe a confirmed case of measles in someone who developed immunity to measles, either from natural measles infection, or from prior receipt of a completed course of measles immunisation, typically between 6 and 30 years after infection or immunisation (**Section 1.6.3)**. Breakthrough infection is usually associated with intense and/or prolonged exposure to an infected individual, e.g. directly caring for an acutely ill person, and so is generally only seen in healthcare workers or in household settings.

Cases of breakthrough measles are generally mild, conjunctivitis is generally absent, and the rash may not follow typical progression. The illness tends to be of shorter duration, and the infectivity of these cases is much lower and transient, unlike primary measles infection. Although polymerase chain reaction (PCR) positive, the presence of neutralising antibodies in respiratory secretions greatly reduces the infectiousness of the virus.

Breakthrough cases of measles are uncommon. In a highly vaccinated population measles, and in particular, severe cases of measles, are exceedingly rare. Current PCR testing protocols are highly sensitive even to low levels of virus, which enables identification of mild and subclinical illness. When

breakthrough cases of measles are identified in such populations, cases are typically clinically mild and are not thought to pose a significant public health risk in the context of global elimination efforts.

1.3.7 Rash illness 10 to 12 days post-MMR (mini measles)

MMR is a live attenuated vaccine, and some individuals can develop a rash 10 to 12 days post vaccination (mini measles). Individuals may have a mild fever but are otherwise well. Note: individuals with post vaccination mini measles cannot pass measles on to others. Measles virus can be detected in oral fluid (OF) samples and mouth and throat swabs. As standard PCR testing cannot distinguish between vaccine and wild-type measles, samples from these cases should be sent to UCD NVRL for either their measles vaccine-specific PCR assay or formal genotyping.

1.4 Surveillance of measles

Regional Departments of Public Health should work with local partners to raise awareness of measles among healthcare professionals to facilitate early recognition, diagnosis and reporting (see Chapter 2). A national enhanced surveillance programme for measles (encompassing all notified and suspected cases) is coordinated by the Health Protection Surveillance Centre (HPSC). The enhanced surveillance information is collected by regional Department of Public Health teams, entered on Computerised Infectious Disease Reporting (CIDR) and validated by surveillance staff in Regional Departments of Public Health. As such, when a suspected case of measles is reported and/or notified to the Regional Department of Public Health, the team should ensure an oral fluid (OF) sample from the case is sent to the WHO National Measles Laboratory at UCD NVRL for analysis.

Results are reported back both to the patient's clinician and to the Regional Department of Public Health. Instructions for -ordering oral fluid kits can be found online. Ideally, a serum sample should also be sent to provide a more comprehensive picture of the patient's measles status: however, it is recognised that phlebotomy may not be feasible on younger patients, or if it is not possible to safely bring a patient into a primary care or other healthcare setting due to infection, prevention and control (IPC) limitations. Staff from the Regional Department of Public Health follow up notified cases to obtain further epidemiological and clinical information and to document vaccination history where not already gathered.

1.4.1 International surveillance standards

To maintain endemic measles elimination in Ireland, the surveillance system should be able to identify and test all suspected cases of measles, reliably exclude cases based on appropriate laboratory testing in a WHO accredited laboratory and define chains of transmission (14). To support the national surveillance system, laboratory testing of suspected measles cases is undertaken at UCD NVRL, the WHO National Measles Laboratory for Ireland. This enables systematic testing, using reference methods which are both highly sensitive and specific. Adequate testing to discard a high proportion of suspected cases, using WHO approved methods, is an important indicator of the sensitivity of the Irish surveillance system and is a requirement in the WHO process of certifying measles elimination

Confirmatory testing, genotyping, and further characterization of the measles virus are undertaken at UCD NVRL. Measles virus sequences are entered on the WHO global Measles Nucleotide Sequence (MeaNS) database hosted by UKHSA. UCD NVRL also report monthly data on the number of samples tested for measles to the WHO laboratory network.

The HPSC is the central repository of all notified cases in Ireland and the regional Department of Public Health conducts systematic follow up of all notified cases in their respective cases. Epidemiological data including travel history, visits to healthcare settings and attendance at mass gathering events should be collated by the regional Department of Public Health (see the **Enhanced Surveillance Form (ESF)**). When combined with genotyping, this enables classification of imported cases and the identification and disentangling of local clusters. This process is critical to maintaining elimination, to identifying pockets of susceptibility, and inform appropriate public health interventions.

1.5 Laboratory investigation

Further Irish guidance on testing for measles can be found **here**.

1.5.1 Types of samples

Measles is a single-stranded RNA virus (genus *Morbillivirus*, family *Paramyxoviridae*). There are 24 described genotypes, many of which have been eliminated as part of the global control of measles. As of 2021, fewer than 3 genotypes are currently found globally, the distribution of which varies across geographic areas. At the time of writing (August 2024), measles cases attributed to genotypes B3 and D8 have been reported in Ireland in 2024. Of note, the measles vaccine virus is genotype A.

For WHO reporting purposes, a measles antibody test is required to exclude measles infection. Genotyping of confirmed samples is also an integral part of laboratory surveillance for measles, to identify imported cases and maintain elimination. In Ireland, oral fluid (OF) is the optimal sample for measles diagnosis. These samples are minimally invasive and are more acceptable than serum for confirming cases in infants and children. Importantly, OF can be tested for measles-specific IgM, and measles RNA, and can therefore:

1. Reliably exclude measles diagnosis, as well as confirm it.
2. Facilitate the genotyping of confirmed cases.

In the absence of an OF sample, a serum sample and a mouth swab for viral culture should be sent to UCD NVRL instead. It is important to note that oral fluid samples cannot be used to assess the immune status of vulnerable contacts and serum should be used instead. Figure 7 provides an overview of the timing of laboratory tests and biological parameters for measles diagnosis. Table 2 provides a summary of the sample types accepted, and the tests performed at UCD NVRL.

1.5.1.1 Oral fluid

Oral fluid (OF), also known as gingival crevicular fluid, is a plasma transudate that emerges at the margin of tooth and gum. This transudate contains IgM and IgG derived from plasma but diluted. OF is the optimal sample for measles surveillance and should be taken from all suspected cases regardless of any other samples that may have already been taken, including when other laboratory methods have not confirmed measles. OF can be tested for both measles IgM and viral RNA. Testing for IgM on OF is more sensitive and more specific than serum, particularly in the first few days after the rash, as IgM antibodies are positive in over 50% of samples on day one of the rash, and in over 90% by day 3 of the rash (Figure 7). For oral fluid samples taken within 7 days of onset of disease, the UCD NVRL also performs PCR analysis for RNA detection.

Measles virus RNA can be detected during the prodrome of suspected measles infection, before the onset of the rash and up to 7 days post rash onset. IgM is detectable from the day the rash develops for up to 4 to 5 weeks thereafter. Genotyping for molecular epidemiology can be performed on PCR positive samples (viral load permitting), which allows the characterisation of the virus into one of the 24 known genotypes and helps identify clusters and imported cases. Measles genotyping also allows for the distinction between wild-type virus and vaccine-derived virus in those developing a measles-like rash ("mini measles") following vaccination.

OF is not appropriate to assess the immune status of contacts, for which serum should be tested instead (see below).

1.5.1.2 Serum

Serum samples can be used for IgM/IgG detection through enzyme immunoassays (EIA), or chemiluminescence immunoassays (CLIA). Serum is the most appropriate sample to assess the immune status of contacts. Measles IgM can be detected in serum 4 days after rash onset. Serum can be used to confirm breakthrough measles (reinfection) by detection of high avidity measles IgG. However, measles IgG avidity testing is not available at the NVRL and is not routinely indicated. In cases or outbreaks in which avidity testing might be useful, serum samples can be referred – on request – by the NVRL to the Virus Reference Department, UKHSA Colindale. Serum is generally not suitable for PCR detection and viral typing. Serum cannot be used to distinguish wild-type measles from vaccine-derived measles following recent vaccination.

1.5.1.3 Viral mouth swabs

Viral throat or mouth swabs can be used for PCR if collected within 6 days of the onset of rash. These should be taken by a healthcare professional except in rare circumstances where clinical need necessitates an urgent test and alternatives are not available. A negative PCR result does not exclude a diagnosis of measles. Viral mouth swabs can be used to distinguish between wild-type virus and vaccine in someone who has recently been vaccinated. Viral mouth swabs cannot be used for measles IgM/G testing and cannot be used to distinguish between a primary infection and a breakthrough measles (reinfection).

1.5.1.4 Throat swabs or nasopharyngeal aspirate

Such samples can be used for PCR if collected within 6 days of the onset of rash (see Figure 7) but these should be collected by a health care professional. As with mouth swabs, a negative PCR result does not

exclude a diagnosis of measles. Sputum samples, nose swabs, and eye swabs are not suitable for measles testing.

1.5.1.5 Urine

Urine samples can be highly variable and are therefore not routinely advised for measles testing in Ireland.

1.5.1.6 EDTA blood

EDTA blood is not recommended for measles investigations.

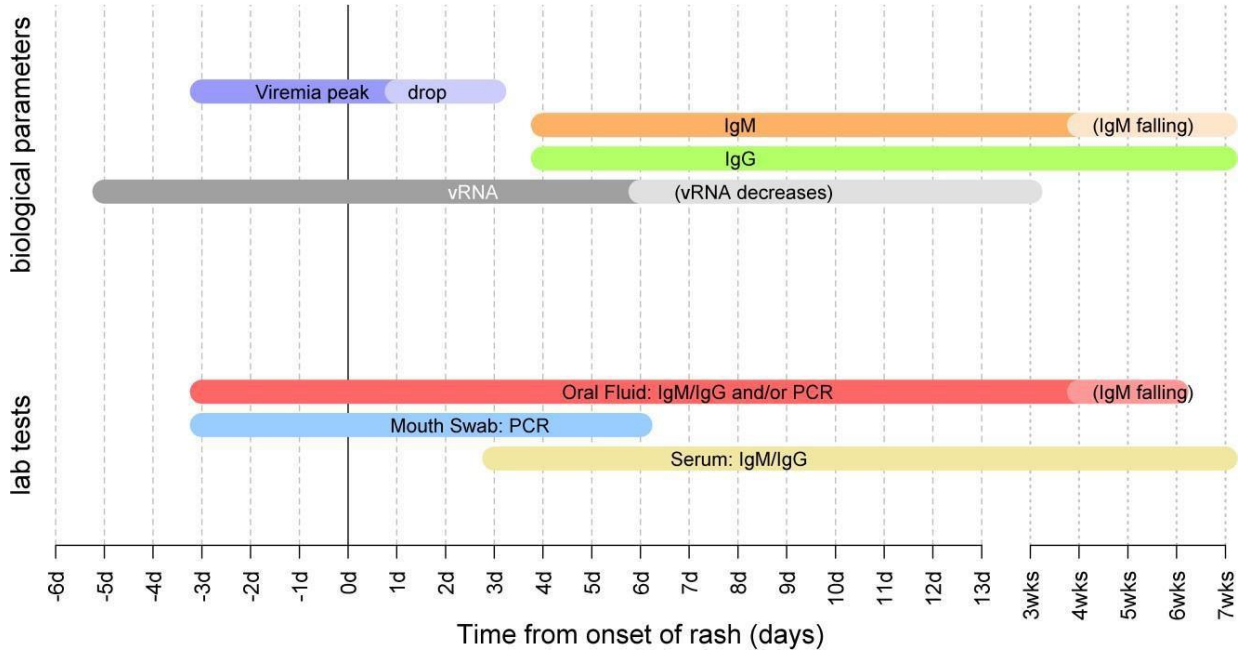

Figure 7. Dynamics of biological or viral indicators and timings of laboratory tests during primary measles infection (4).

Table two below represents a summary of sample type and test performed at NVRL.

Sample Type	IgM	IgG	Measles RNA (PCR)	Useful for
Oral fluid (Oracol swab)	✔ (day of rash onset up to 4-5 weeks post rash onset)	*x*	✔ (prodrome and up to 7 days post rash onset)	• Early (pre-rash) measles infection • Acute measles infection • Out rule measles infection (discard possible cases based on IgM results) • Measles genotyping
Serum sample	✔ (4 days post rash onset)	✔	*x*	• Acute measles infection • Out rule measles infection (discard possible cases) • Immune status • Primary infection vs breakthrough infection
Throat/mouth swab (VTM or UTM)	*x*	*x*	✔ (within 6 days of ash onset)	• Acute measles infection • Measles genotyping
EDTA blood	Not recommended			
Urine	Not recommended			

Table 2: Summary of sample type and test performed at NVRL (29)

1.5.2 Collection of samples

Kits for collecting routine surveillance oral fluid samples are available through the HSE (details available **here**). Kits should be available in relevant assessment areas e.g. Emergency Departments (ED), GP clinics. It is important that the sample is collected according to the instructions (available **here**). The swab needs to be rubbed along the gum line for 2 minutes. If young children chew on the swab whilst the sample is being collected it should not compromise the sample collection. Sputum samples are not suitable for testing.

Oral fluid samples sent for measles IgM testing are also tested for total IgG as an indication of whether the sample is suitable for testing. If the total IgG is negative, then this indicates a poor-quality sample and the test may need to be repeated. If oral fluid collection kits are not available, then a serum sample plus mouth swab can be taken instead (and sent to UCD NVRL).

A mouth swab should be collected by rubbing the swab along the gum line and then over the tongue.

Note: any viral swab may be used for measles PCR testing, including a dry swab. A bacterial swab cannot be used as these contain PCR inhibitors.

1.6 Measles Case Definitions

Clinical criteria

Any person with fever AND maculo-papular rash AND at least one of the following three:

- Cough
- Coryza
- Conjunctivitis

Laboratory criteria

At least one of the following four:

- Isolation of measles virus from a clinical specimen
- Detection of measles virus nucleic acid in a clinical specimen
- Measles virus specific antibody response characteristic for acute infection in serum or saliva
- Detection of measles virus antigen by DFA in a clinical specimen using measles specific monoclonal antibodies

Laboratory results need to be interpreted according to the vaccination status. If recently vaccinated, investigate for wild virus.

Epidemiological criteria

An epidemiological link by human-to-human transmission

Case classification

A. **Possible case**: Any person meeting the clinical criteria

B. **Probable case**: Any person meeting the clinical criteria and with an epidemiological link

C. **Confirmed case**: Any person not recently vaccinated and meeting the clinical and the laboratory criteria

1.6.1 Presumed primary infection

A laboratory confirmed case with no serological evidence of prior exposure to measles infection or vaccination.

1.6.2 Presumed breakthrough measles (reinfection)

Detection of measles virus RNA in a suspected case of measles with a reliable history of having received 2 doses of measles containing vaccine.

Breakthrough measles might also be suggested by a high levels of measles specific IgG in serum at, or near, the onset of illness.

1.6.3 Measles IgG testing of contacts

Assays can be either qualitative, where results are reported as positive, negative, or equivocal, or quantitative, where a defined measure of antibody level is provided. Enzyme immunoassays (EIA) are commonly used to test for measles IgG antibody, and various assays are available. A positive test is useful to avoid unnecessary use of human normal immunoglobulin (HNIG) or intravenous immunoglobulin (IVIG). However, although the specificity of most qualitative EIAs is high, their sensitivity remains low, and recommendations about post-exposure prophylaxis for equivocal results will differ by age and type of vulnerability (see PEP guidelines below). Most if not all assays used in Ireland are qualitative.

Chapter 2 Public Health Management

2. Public health management

2.1 Assessment of the index case

When measles is not endemic, the positive predictive value of a clinical diagnosis is generally poor. In the absence of laboratory results, the likelihood of measles will therefore depend upon an assessment of the epidemiological features.

Case management should commence based on this assessment, without waiting for the results of laboratory testing (even when requested urgently). Public health professionals should advise, as needed, on the use of appropriate laboratory samples for testing, at the right time, to reduce the likelihood of false negative results. See Figure 7 **Chapter 1** and the Laboratory Investigation of Measles Infection document (30) for optimal timing of suitable clinical samples for measles testing.

2.1.1 Case management definitions

The regional Public Health Team should conduct a public health risk assessment (PHRA) for every suspected case of measles reported by a clinician to decide on management. For cases that are reported from sources other than a clinician, if the source is considered reliable and the history of the illness is compatible, the case should be managed as a suspected case whilst seeking further information. “Patient information required for assessment of suspected measles cases” below summarises the information to collect. All suspected cases should be entered onto CIDR or alternative Outbreak Case and Management and Surveillance system (OCIMS) by the regional Public Health Team.

Each case should be promptly investigated and classified according to laboratory results, clinical features, and epidemiological features. For each reported case the classification may change as more information (for example on the epidemiology or laboratory results) becomes available.

Patient information required for assessment of suspected measles cases

Demographic details

- Name
- Gender
- Date of birth
- Address
- Contact details

- Individual Health Identifier (IHI)
- Country of birth
- Ethnicity

Clinical and laboratory features

- **Signs and symptoms**: collect information on signs and symptoms including onset and duration of symptoms,
- **Rash**: date of rash onset, description of rash, distribution and spread
- **Laboratory results**: document the type of tests conducted and results

Individual epidemiological features

- **Travel**: any travel within and outside Ireland during the incubation period, with an assessment of whether travel was in an area where measles is known to be circulating
- **Ethnic and cultural or religious background**: obtain details on the patient's ethnicity, and importantly, assess whether the patient is a member of a community potentially more susceptible to measles due to under-vaccination (for example, Irish Traveller, Roma, Steiner community)
- **People experiencing homelessness, people living in congregate settings**
- **Immunisation history**: any known vaccination history or history of measles; if not known, ask where the patient was born and grew up to help assess the likelihood of vaccination and/or natural exposure
- **Epidemiological link**: assess if there has been a known epidemiological link with another laboratory confirmed case or probable case

Measles enhanced surveillance form is available **here**.

Please see Chapter 1 for measles case definitions for Ireland.

Table 3. Clinical features of measles

	Symptoms

Classical primary measles: generally, very unwell and considered measles until proven otherwise	• Fever equal to or over 39°C in the absence of antipyretics, and
	• Generalised maculopapular rash, and
	• One or more of the 3Cs of measles:
	  ○ conjunctivitis
	  ○ cough
	  ○ coryza

Mild: generally, a milder illness	• Fever typically 37.5°C to 39°C • Rash may be more localised • May not have conjunctivitis, coryza or cough
Rash or fever following vaccination	Rash and mild fever on day 10 or 11 post-MMR vaccination is likely to be vaccine related

For images of a measles rash and Koplik spots, please see **here.** Please note that skin pigment may affect the appearance of the rash.

Epidemiological information is a better predictor of measles than the clinical features.
Given the implications of an incorrect classification, it is recommended that classification for public health management should be undertaken by or in discussion with an experienced member of the public health team.

Factors to consider in the risk assessment

Factors increasing the risk of exposure

- **Membership of a community potentially more susceptible to measles (due to under-vaccination)**, for example, Irish Traveller community, Roma community, Steiner communities, local community with low MMR vaccination coverage (14, 31) or living in settings where measles is more likely to spread, for example, people living in congregate accommodation settings (e.g. people who are homeless, or refugees and applicants seeking protection)
- **Visited an area** (local or international) where measles is known to be circulating, during the incubation period

- **Attendance at large international mass gathering events**, where substantial mixing occurs between individuals potentially travelling from areas where measles is circulating; this would include, for example, events such as music festivals or sports events (32)

Factors favouring the diagnosis of primary measles infection

- **Age**:
  - the likelihood of a suspected case being confirmed as measles is higher among adolescent and young adults. In infants and toddlers, measles-like clinical presentations due to other illnesses, such as roseola or scarlet fever, are common (see **Appendix 2**).
  - individuals born in Ireland before 1978 are likely to be measles immune through natural infection.
- **A lack of immunity or incomplete vaccination**: the diagnosis is more likely if cases are unvaccinated or partially vaccinated and have no prior history of measles infection.

Oral fluid testing

For accurate exclusion of measles, from a public health perspective, an oral fluid (OF) sample should always be requested in clinically suspect cases. Refer to **Chapter 1 Section 1.5** for further information regarding oral fluid sampling.

Contacts of epidemiologically or laboratory confirmed cases (by other methods) should be risk assessed and managed without awaiting the result of the oral fluid test in the index case. Immunocompromised contacts of suspected cases (including breakthrough measles (reinfection)) should be risk assessed and managed without awaiting the result of the oral fluid test in the index case as per **Section 2.2.3**.

Serology

Ideally, a serum sample should also be sent however it is recognised that phlebotomy may not be feasible on younger patients or if it is not possible to safely bring a patient into a primary care or other healthcare setting due to IPC limitations.

Refer to Chapter 1 Section 1.5 for further information regarding serology.

2.1.2 Risk assessment

The risk assessment should consider the clinical features, epidemiological features, vaccination history and laboratory results to decide on the need for further testing and post- exposure prophylaxis of vulnerable contacts. Figure 8 and Figure 9 illustrate the principles of risk assessment, indications for testing and which test to use.

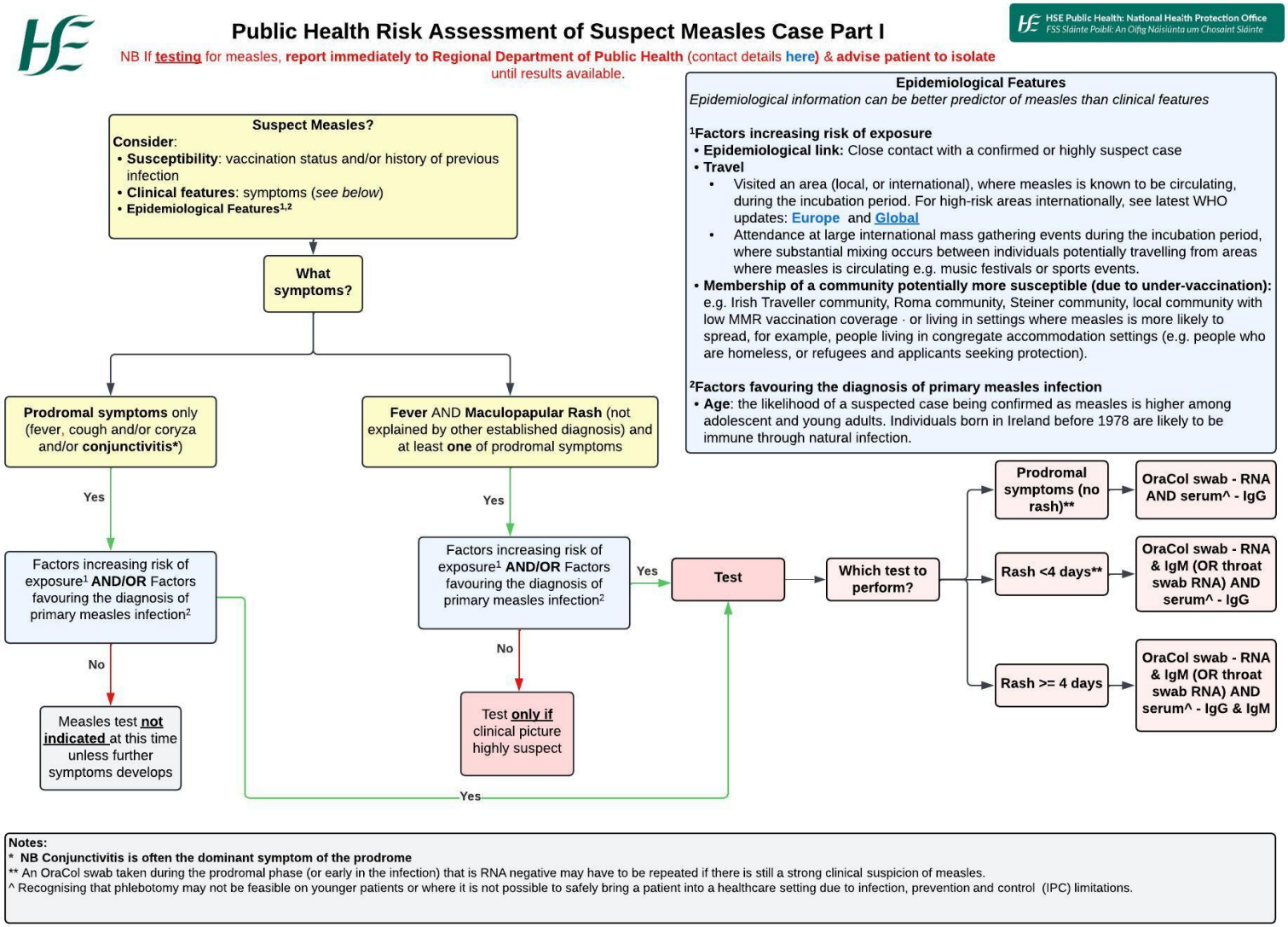

Figure 8 Public Health Risk Assessment of Suspect Measles case Part I.

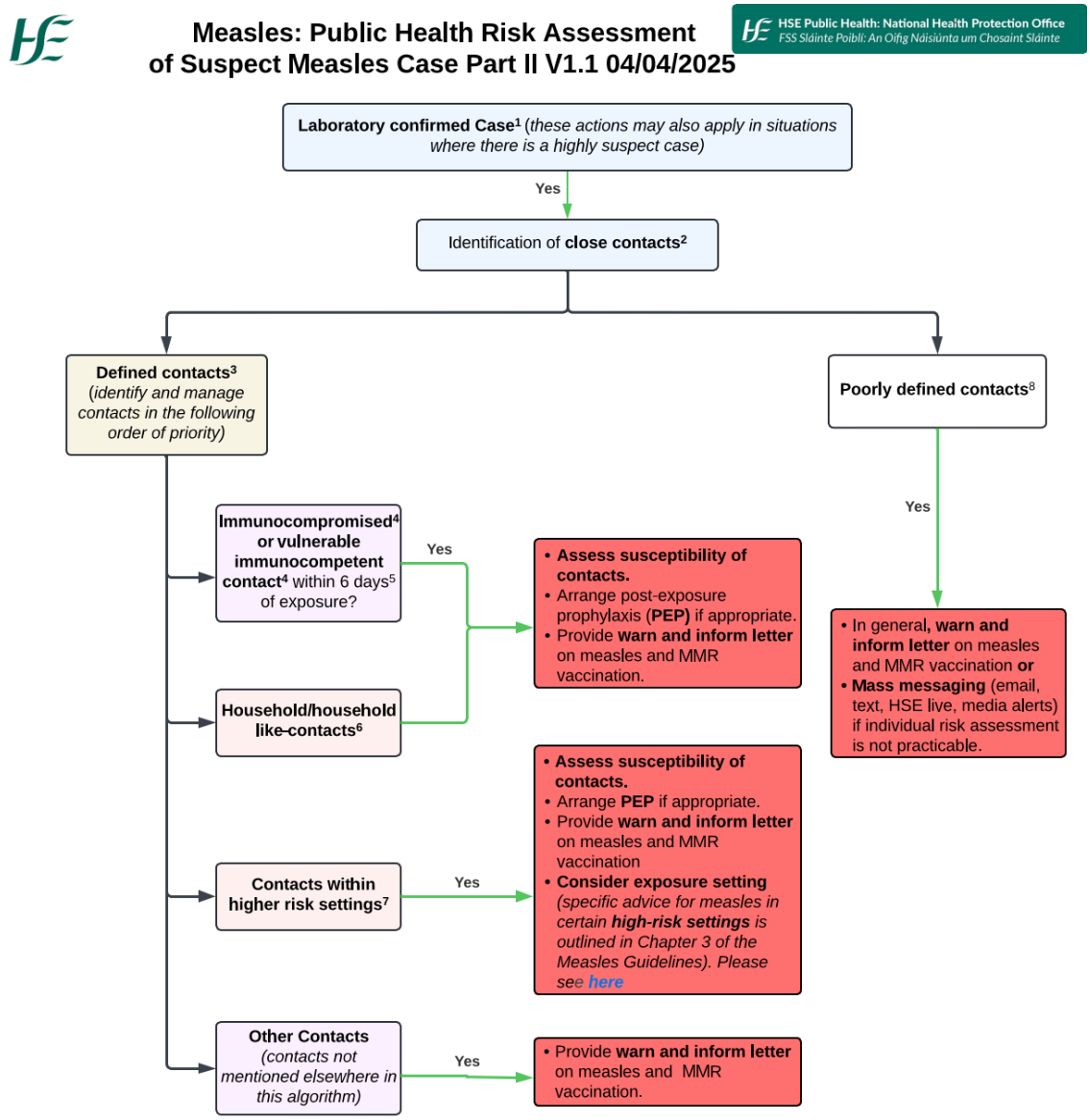

Figure 9 Public Health Risk Assessment of Suspect Measles Case Part II.

2.1.3 Exclusion of the index case

Confirmed and suspect (due to clinical and/or epidemiological features) cases should stay at home and avoid contact with vulnerable people and are therefore **excluded** from school, childcare facilities (CCF) or work for the entire period of infectiousness (from four days prior to the onset of the rash to four days after the rash erupts). Given the high risk of secondary infection following measles, it is **advisable** to return to school, CCF or work only after the period of infectiousness and after full recovery from measles illness.

Immunocompromised individuals may be infectious for longer and may not display typical symptoms, therefore timings should be adjusted as appropriate in consultation with clinicians managing the case's immunosuppression. More information on immunocompromised individuals is available in NIAC Immunisation Guidelines (3, 27).

Details on exclusion of healthcare worker contacts and close contacts from educational settings are provided in **Section 3.2.3** and **Section 3.3** respectively.

2.2 Management of contacts and post-exposure prophylaxis

2.2.1 Identification of contacts

The best way to protect individuals and to achieve measles elimination is with high vaccination coverage (95% and over) with 2 doses of MMR vaccine for all individuals aged 12 months and older. There is a duty of care to follow up each reported case of measles with the aim of identifying others who may have been exposed, both to a common source of infection and to the reported case. This will help to ensure timely identification of chains of transmission and inform the need for pro-active interventions to prevent tertiary and subsequent waves of measles infection. Where practicable, all contacts should be provided with information to alert them to the symptoms of measles and should be advised to exclude themselves from schools or other settings if they develop symptoms.

While the evidence for the effectiveness of post exposure prophylaxis is limited, it is likely to provide some protection to exposed susceptible vulnerable contacts when administered within 72 hours (3, 33-35). This requires identification of contacts in the following order of priority:

1. Immunocompromised contacts, pregnant women and infants less than 12 months
2. Healthcare workers (HCW) / Irish Prison Staff (IPS) (prisons and places of detention)/ Childcare facility (CCF) staff
3. Healthy contacts.

The management of each identified contact will depend on their exposure risk (including whether the index case is presumed to be primary or breakthrough measles (reinfection)) and their vaccination status or susceptibility to measles. For immunocompromised contacts, an appropriate assessment of the nature and level of immune suppression is essential to assess the requirement for post-exposure prophylaxis.

Guidance on the management of contacts is based largely on the assessment of individuals born and raised in Ireland. In many other countries, a higher proportion of older adults are likely to be immune due to previous infection and therefore applying the guidance for Irish-born individuals to people living in Ireland but born elsewhere is a safe approach. However, individuals who have come from a small number of countries where measles control has been achieved for a longer period than in Ireland and are not known to be fully vaccinated, may remain susceptible to measles at an older age. For example, individuals from the USA can generally only be assumed to be immune if fully vaccinated or born before 1957 (36). Similar considerations may apply for individuals from Canada and some Scandinavian countries. Therefore, testing of individuals of all ages from these countries may be required, if they are not known to be fully vaccinated.

2.2.2 Defining exposure risk and contact

Exposure Risk

NIAC Guidance (3) describes the following regarding exposure risk.
Exposure to measles is considered significant if a susceptible individual is exposed to a confirmed or probable case of measles during the infectious period (from four days prior to the onset of the rash to four days after the rash erupts) in any of the following ways:

- Face-to-face contact of any duration.
- An immunocompetent individual is in a room with the case for more than 15 minutes. This includes those who may have been exposed to measles in the setting of an emergency department or an outpatient clinic where the intensity of such exposure cannot accurately be judged.
- An immunocompromised person is in a room with the case for any duration or enters a room vacated by a case within two hours of the case leaving the room.
- In-utero exposure to maternal measles where maternal measles rash occurs within six days before to six days after birth.

Categorising Contacts

Defined contacts are those in situations or settings where all contacts can be individually identified in addition it is also possible to more accurately gauge the level of exposure. Poorly defined contacts are those in situations or settings where the level of exposure is unclear, and not all individual contacts can be identified, e.g. in hospital ED or outpatients, a list of identifiable patients can generally be obtained, however any persons accompanying the patient at the time won't be recorded.

2.2.2.1 Defined contacts

Contact tracing should identify close contacts within the infectious period, (from four days prior to the onset of the rash to four days after the rash erupts). In the absence of rash, one approach is to commence the presumed infectious period one day before onset of prodromal symptoms. Generally, secondary transmission is higher among close contacts, such as members of a household or individuals who have close contact with each other over a long period of time, or students in the same classroom (18, 19).

Immunocompromised individuals

Whilst most transmission events require face-to-face contact, transmission through more casual contact does occur (16, 17). For immunocompromised individuals, who are more likely to develop severe measles disease (21), it is particularly important to consider even limited exposure. Any level of contact should trigger an assessment of an immunocompromised individual, even if the index case

is presumed to be breakthrough measles (reinfection). If immunocompromised contacts are identified, assessment of their susceptibility and post-exposure prophylaxis should be considered without waiting for, or in parallel with, laboratory testing of the index case.

Due to the potential for live attenuated vaccines to replicate and cause disease in immunocompromised individuals, inadvertent administration of MMR to an immunocompromised individual should be risk assessed as a potential exposure to measles (further details are in the next section). See also **Chapter 3 NIAC guidelines** (27).

Vulnerable immunocompetent individuals (infants, pregnant women)

For immunocompetent vulnerable individuals (infants, pregnant women), Regional Departments of Public Health should prioritise contact tracing efforts to those most likely to have had close or prolonged exposure to a primary measles infection. If the index case is presumed breakthrough measles (reinfection), individuals in this group do not need to be identified and assessed.

Other contacts

For immunocompetent individuals, including healthcare workers, Irish Prison Staff and childcare workers, significant exposure is defined as being in a room with the case for more than 15 minutes. Contact tracing should prioritise this group of immunocompetent contacts.

2.2.2.2 Poorly defined contacts

There will often be situations where several individuals may have been exposed in a shared setting, for example hospital Emergency Department, GP surgery, healthcare facility waiting area, or communal area in a congregate accommodation setting where the level of contact is unclear. When the information provided cannot clearly define the level of contact but there are known immunocompromised individuals involved, these should be managed as close contacts and rapidly assessed for post-exposure prophylaxis.

Where there is a defined list of contacts, but it is not clear if the group contains immunocompromised individuals, an individual risk assessment is not practicable. In this situation, warn and inform letters or messaging should be issued to all potential contacts.
If there is no identifiable list of contacts at all, then other means of case finding should be considered, such as writing to local healthcare providers, information leaflets or posters in public areas, alerts in the media and other communication activities as relevant to the setting.

2.2.3 Immunocompromised contacts

2.2.3.1 Assess risk and susceptibility

All immunocompromised patients, as defined in **Chapter 3** and **Chapter 12 NIAC Immunisation Guidelines** are at risk of severe measles and should be considered for intravenous immunoglobulin (IVIG) following any exposure to measles, which would need to be sourced from hospital pharmacies (3, 27).

Prophylaxis will depend on the level of immunosuppression and the likelihood that the individual would have retained any pre-existing measles immunity. Many adults and older children with immunosuppression will have immunity due to past infection or vaccination. A prophylactic dose of immunoglobulin is unlikely to offer additional benefit to those who have detectable measles antibody using standard assays, as their antibody levels are probably significantly higher than those achieved after a prophylactic dose of immunoglobulin.

People with severe defects of cell mediated immunity who are on regular IVIG replacement therapy do not require additional IVIG if the most recent dose was administered 3 weeks or less before exposure. Such individuals should be under the management of specialists in immunology and their need for replacement immunoglobulin therapy will have already been assessed by their immunologist.

All other individuals who are immunocompromised not already on IVIG replacement therapy will require assessment at the time of an exposure. These individuals can be divided into 2 main groups (Table 4), depending on their ability to maintain adequate antibody from past exposure or vaccination.

Table 4 Level of immunosuppression depending on diagnosis or type of immunosuppression therapy (27)

Level of Immunosuppression	Illness or immunosuppressive therapy
Group A	immunosuppression illness or on immunosuppression therapy, other than those described in groups Bi and Bii
Group B(i)	• Leukaemia • Lymphoproliferative disorder • Post solid organ transplant • Patients ≥12 months post haemopoetic stem cell transplant (HCST) • Receiving or within six months of completion of biologic therapy • Diagnosis of AIDS
Group B(ii)	• Patients < 12 months post HSCT • Severe primary immunodeficiency

Group A

Group A includes most patients who are immunocompromised. These individuals should be able to develop and maintain adequate antibody from any prior successful vaccination or infection and can therefore be managed on the basis of evidence of protection (including history of natural infection or prior measles antibody test results) at any time prior to or since the immunocompromising diagnosis or treatment end.

Patients in this group are likely to have developed an adequate response to vaccination or measles during childhood, and so it is recommended that their measles status is established prior to exposure (for example at the next out-patient appointment) so that post-exposure prophylaxis can be informed. For individuals born and raised abroad, where the history of measles may be less reliable, an individual risk assessment, ideally with rapid IgG antibody testing, is recommended.

Group B

Group B includes individuals who are severely immunocompromised and may not have developed or maintained adequate antibody levels from past exposure or vaccination.
This group can be further subdivided into:

- B (i) individuals who can be managed based on a measles IgG test urgently requested following exposure regardless of past vaccination history or previous serologic test result.
- B (ii) individuals who require IVIG following an exposure without the need for testing and regardless of immunologic or vaccination status.

In principle, immunocompromised individuals should have been re-vaccinated (when they have recovered sufficiently to receive live vaccines) or have had their immunity against measles tested, after completing their treatment. Any measles exposed patient who has recovered but **has not** been revaccinated may need their measles IgG checked and be considered for IVIG. The supervising clinician will be able to advise if the patient is fully recovered or if they remain immunocompromised.

Other individuals

Other individuals who do not meet the criteria for either Group A or B (for example, HIV positive individuals with CD4 cell count greater than 200/mm3, individuals receiving non-biological immune modulating drugs more than 3 months ago), should be considered as immunocompetent for the purposes of measles PEP. However, the decision on the use of IVIG in these groups may be taken on an individual basis by their specialist clinician.

2.2.3.2 Management of immunocompromised contacts

Group A

Patients in group A should be urgently assessed for the need for IVIG. In the absence of a positive measles IgG test at any time (i.e. either prior to or since immunocompromising diagnosis or treatment, at the time of measles exposure), an assessment of susceptibility needs to be urgently undertaken based on the individual's age, history of measles infection and vaccine status (see Table 3).

For those requiring IgG testing, this should be done as soon as possible following exposure, given that the effectiveness of IVIG is likely to be higher when administered as early as possible following exposure (ideally within 72 hours) although it can be given up to 6 days following exposure. Urgent IgG testing is available at NVRL. Most testing can be done the same day or out of hours.

Group B

For patients in group B (i) urgent IgG testing should be conducted at the time of exposure, regardless of past vaccination history or previous serologic test result. If measles IgG is detected, post exposure prophylaxis is not required. If seronegative, offer post exposure prophylaxis. If it is not possible to test within 72 hours of exposure, IVIG should be administered.

For patients in group B (ii), IVIG should be provided regardless of previous measles IgG results and without the need for testing.
For patients in group Bi and Bii, IVIG, if required, needs to be provided as soon as possible after exposure, ideally within 72 hours, but can be administered up to 6 days following exposure.

For immunocompromised patients where exposure is recognised late or who are found to be antibody negative or equivocal more than 6 days after exposure, discussion with the specialist caring for the individual should take place, and IVIG may be considered to attenuate infection. Where a second exposure occurs more than 3 weeks after a first dose of immunoglobulin, a further dose of immunoglobulin will need to be considered.

Table 5. Assessing evidence of protection in immunocompromised contacts of measles

Table 5a Group A: individuals who are expected to develop and maintain adequate antibody from past exposure or vaccination

All ages	**Previous measles IgG positive**	**Assume immune – do not give IVIG**
Born in Ireland before 1978	Positive history of measles infection	Assume immune – do not give IVIG
	No history of measles infection	Rapid IgG test – give IVIG if negative or equivocal If not possible to test within 6 days of exposure – assume immune, - do not give IVIG
Born during or after 1978 or born outside of Ireland	History of 2 measles containing vaccines	Rapid IgG test – give IVIG if negative or equivocal If not possible to test within 6 days of exposure – assume immune, - do not give IVIG
	History of 1 measles containing vaccine	Rapid IgG test – give IVIG if negative or equivocal If not possible to test within 6 days of exposure – give IVIG
	Unvaccinated	Rapid IgG test – give IVIG if negative or equivocal If not possible to test within 6 days of exposure – give IVIG

Table 5b Group B: individuals who lose or may not maintain adequate antibody levels from past exposure or vaccination

Group B(i) – all ages	Urgent IgG testing should be conducted at the time of exposure, regardless of past vaccination history or previous serologic test result.	Give IVIG if negative of equivocal If not possible to test within 3 days of exposure – give IVIG
Group B(ii) – all ages	Offer IVIG regardless of IgG status	

Immunocompromised individuals who receive IVIG should wait at least eight months before receiving MMR or varicella vaccination (37).

2.2.4 Immunocompetent vulnerable contacts: pregnant women

2.2.4.1 Assessing susceptibility

An Irish seroprevalence study showed that 95% of children aged 11-14 years, attending Paediatric outpatients in Dublin in 1991-1992 had antibodies to measles (38). Younger adults may have been naturally infected or vaccinated with a single dose of a measles – containing vaccine (MCV) as children (from 1985 onwards), with those aged 10-14 years in 1992 eligible for a second dose of measles-containing vaccine. Routine measles IgG tests are likely to be specific and therefore have a high positive predictive value in adult populations (39). Individuals who tested IgG positive or equivocal for measles antibody on standard assays were all shown to have detectable measles antibody by neutralisation assays. Therefore, HNIG is unlikely to offer additional benefit to individuals who are measles IgG positive or equivocal. As routine antibody tests lack sensitivity, however, a high proportion of those found to be measles IgG equivocal or negative are likely to be truly immune.

2.2.4.2 Management of pregnant contacts

All non-immune pregnant women and those whose immune status is unknown who are exposed to measles should have an urgent IgG test.

NIAC recommendation

HNIG should be administered to pregnant women without evidence of measles immunity who have had significant exposure to measles. Ideally it should be given within three days of exposure but can be given up to six days, allowing time for assessment of immunity status in most instances. Women with measles IgG titres reported as ‘positive’ or ‘weak positive’ are likely to have measles vaccine or infection induced immunity and do not need HNIG.

The main aim of measles PEP for pregnant women is attenuation of disease. Where a second exposure occurs more than 3 weeks after a first dose of immunoglobulin, a further dose may need to be considered. Pregnant women who remain susceptible and who do not have a history of 2 doses of MMR vaccine, should be reminded to have MMR vaccination following delivery to protect them in subsequent pregnancies. In addition, there should a gap of at least six months from receipt of HNIG and routine MMR or varicella vaccination in this cohort. (37)

2.2.5 Immunocompetent vulnerable contacts: infants

Most Irish born women of reproductive age were born after routine measles vaccination was introduced in Ireland and are unlikely to have had exposure to natural measles infection. Among vaccinated women, the levels of trans-placentally acquired antibodies in their babies tend to be low and to wane rapidly, generally in a few weeks after birth (40, 41). If pregnant women have had a history of measles, maternal antibodies may protect for longer, but recent evidence shows that passive maternal immunity is unlikely to confer effective protection later than a few months after birth (40, 41).

In-utero exposure to maternal measles

Where maternal measles rash occurs within six days before to six days after birth, the neonate should receive HNIG, ideally within three days of exposure. It can be given with potential benefit up to six days following exposure. Special consideration is required for preterm or low birth weight infants[b].

Infants aged < 6 months[c]

All infants under 6 months old who have a household or household type exposure to measles should get HNIG, due to the high likelihood of maternal antibodies interfering with the response to MMR vaccine, ideally within 3 days of exposure. HNIG can be given with potential benefit up to 6 days.

For non-household exposure if the infant's and mothers' measles IgG status can be ascertained within three days of exposure and is IgG positive, HNIG is not indicated. If the measles IgG result is weakly positive, equivocal, negative or unknown, HNIG is recommended, and should be given within three days. It can be given with potential benefit up to six days following exposure.

Infants aged 6-8 months

Infants aged 6 to 8 months who have household or household type exposure, give the MMR vaccine if the exposure was within the preceding 3 days. If the exposure is between 3 and 6 days previously and MMR vaccine has not been given within 3 days of exposure, give HNIG if feasible.

Infants aged 6 to 8 months who have exposures in non-household settings are less likely to have the intensity of exposure to develop severe disease and so should receive MMR vaccine within three days of exposure. If MMR vaccine cannot be given within three days of exposure, HNIG should be considered up to six days.

[b] In consultation with relevant specialists

[c] including premature infants <6 months corrected gestational age

Infants aged 9 – 11 months

Infants aged 9 months or older who have household type or non-household type exposure should receive MMR vaccine, as response to MMR is improved at this age. Ideally the MMR vaccine should be given within 3 days but should be offered at any interval following exposure to offer protection from future exposure or a tertiary wave in that particular setting.

Offering HNIG between 3 and 6 days after exposure is unlikely to offer substantial additional benefit in immunocompetent infants. Where exposure is likely to be on- going (for example following a single case in a nursery or during a community outbreak), MMR offered beyond 3 days may provide protection from subsequent exposures.

Table 6. Assessment and treatment of infants (3)

Age	**Management**	
	Household or household type exposure	Non household exposure
< 6 months	Give HNIG within 3 days (can be given up to 6 days post exposure)	Give HNIG within 3 days (can be given up to 6 days post exposure) unless infant and mother have positive measles IgG serology. If measles IgG result is equivocal, weakly positive or unknown, HNIG is recommended
6-8 months	Give MMR vaccine within 3 days. If not possible, give HNIG up to 6 days post exposure*.	Give MMR vaccine within 3 days^. If not possible, consider HNIG up to 6 days post exposure.
≥9 months	Give MMR vaccine, ideally within 3 days of exposure^^	

*Following HNIG, wait at least six months before MMR or varicella vaccination (see **Chapter 2 Section 2.2.6**)

^If MMR vaccine is given <12 months of age, two further doses are required, at ≥12 months and at least 4 weeks apart.

^^If exposure may be ongoing (a single case in a childcare facility or during a community outbreak), MMR vaccination >3 days may provide protection from subsequent exposures. HNIG is not routinely recommended for this age group in the absence of other indications (e.g. immunocompromise).

Infants who have received HNIG should wait at least six months before receiving routine MMR or varicella vaccination. (37)

Due to interference from maternal antibodies, the efficacy of a dose of vaccine provided between 6 to 11 months of age is lower than that provided at 12 to 13 months (42), and therefore doses offered before one year of age should be discounted (in terms of contributing to their immunity) and children should be offered 2 doses of MMR vaccine according to the national schedule i.e. MMR dose 1 at 12 months of age, (at least 4 weeks after the first vaccine), with a further dose at 4-5 years of age. All additional immunisations should be recorded in the child's immunisation passport and recorded in local/national immunisation systems.

2.2.6 Defining the time window for receiving post-exposure prophylaxis

Household contacts or any contact with ongoing exposure

For household contacts or any contact with ongoing exposure during the episode of illness, e.g. childcare facility, the time window for receiving post exposure prophylaxis should be calculated as follows, depending on type of PEP.

- **PEP MMR**: Where MMR vaccine is being used as post-exposure prophylaxis, given the recipients are likely a lower-risk group, it is reasonable that the 72-hour window is counted from first exposure. However as per NIAC guidance if vaccination within 72 hours of first exposure is not achievable, MMR vaccine should still be offered to susceptible persons as this is a good opportunity to vaccinate previously unvaccinated individuals
- **PEP HNIG**: The decision on the time point of exposure would likely depend on a risk-benefit assessment that considers both the nature of the daily exposure and the potential risk to the exposed individual. Last exposure to an infectious case is used to determine public health guidance for isolation precautions in Ireland and elsewhere, which aligns with taking a more conservative approach to exposure timepoints when offering PEP HNIG to very high-risk individuals. Therefore, it's reasonable to consider last exposure as the time point to begin the six-day window for receipt of PEP HNIG.

Other contacts

For other contacts, the time window for receiving post exposure prophylaxis should be calculated from the last day of exposure. In most instances, susceptible contacts will have been exposed on a single day.

2.2.7 Post-exposure prophylaxis following inadvertent vaccination with measles containing vaccine

Due to the potential for live attenuated vaccines to replicate and cause disease in immunocompromised individuals, administration of MMR to an immunocompromised individual should be risk assessed as a potential exposure to measles and managed as per these guidelines (**Section 2.2**). The risk assessment should be undertaken in consultation with the clinician caring for the immunocompromised patient; if the clinical assessment is that the patient is not sufficiently immunocompromised and can tolerate the attenuated vaccine virus, IVIG is not required.

Pregnant women do not require post-exposure prophylaxis if they are inadvertently given MMR. UKHSA and its predecessor organisations has undertaken surveillance of vaccination in pregnancy since 1981 and the data to date are reassuring with regards to maternal and infant outcomes, when MMR is given in pregnancy or shortly prior to pregnancy (4). However, pregnancy remains a

contraindication to its administration and cases of pregnant women inadvertently given MMR vaccine should be reported to the Health Products Regulatory Authority (HPRA) and followed up.

2.2.8 Re-exposure

If there is significant ongoing or re-exposure to measles following the administration of HNIG SC, the administration of HNIG SC should be repeated at two weekly intervals. If there is significant ongoing or re- exposure to measles following the administration of IVIG, the administration of IVIG should be repeated at three weekly intervals. This advice is based on what is known about the half-life of each product. If required, further advice may be sought from relevant specialist clinicians on a case-by-case basis.

2.3 Dosage and administration of immunoglobulins

Although not all HNIG products are licensed for post exposure prophylaxis, their use has proven effective in preventing or attenuating measles if given within six days of exposure. Dose recommendations for post-exposure prophylaxis against measles are not well established. See NIAC guidance for information on appropriate dose, administration and adverse effects (3).

Chapter 3 Specific settings and situations

3.1 Measles in settings for underserved populations

3.1.1 Congregate Settings for Underserved Populations

This section outlines an approach to the public health management of a confirmed or suspected case of measles in a congregate setting[d], with a focus on congregate living settings for underserved populations such as refugees and applicants seeking protection, or people who are homeless. A list outlining examples of these, and other settings posing additional complexity in the management of measles, is included in **Appendix 3**. Much of the following advice will also be applicable to prisons and place of detention, with further specific guidance for these settings is included in **Section 3.1.2** below.

The following actions should be considered as additional measures to usual investigation management and control measures, depending on the severity and risk assessment of the situation, which could be undertaken upon the identification of a confirmed or suspected case of measles in a congregate setting for underserved populations:

- Consider convening an incident management team (IMT) with relevant HSE and external stakeholders after a single confirmed or suspected case

Case(s)

- **Confirm measles** given the potential for transmission of measles in congregate setting, arrange expedited testing of the index case (ORACOL® swab, blood sample where possible, see **Chapter 2 section 2.1.1** for testing guidance).
- **Isolate**: advise that all confirmed and suspect cases are excluded and isolated appropriately:
- It is recommended that congregate living settings for underserved populations have a **plan** in place to identify appropriate facilities on-site where residents who have confirmed/ suspected measles or other infectious disease requiring isolation, can be supported too self-isolate appropriately. This should be in accommodation with separate (‘own door’) access, bathroom and kitchen, or provision for delivery of food to the room.
- It may be appropriate to move confirmed or suspected cases to a **separate housing unit**, if transfer can be undertaken safely, without additional exposure risk, and with cases isolated immediately at the new setting.
- If single occupancy accommodation is not available, confirmed measles cases may be **cohorted** (grouped and isolated) together, but cohorting should only be considered if there are no other options available, except for child cases who should not be separated from their family. See **Appendix 3** for further information on options population-level management in these settings.

[d] Congregate settings refer to settings where people (most or all of whom are not related) live or stay overnight and use shared spaces (e.g. kitchens, bathrooms, communal living areas, common sleeping areas).

- If appropriate space to safely isolate is not available on-site or in another accommodation centre, **early transfer** of the case +/- contacts (if child/family case) to the **National Infectious Disease Isolation Facility (NIDIF)** at St Ita's campus, Portrane, Co. Dublin, should be organised.
- **Seeking further clinical input**: If the health condition of a resident with measles is worsening, accommodation settings are advised to seek clinical advice.

Centre Management

- Obtain list of residents in the accommodation centre during the incubation period from the centre management, including details of any transfers in/out of the setting during the incubation period. Record the layout of the accommodation setting, and the general demographics, ethnicity and country of origin of residents.
- Establish whether there are specific healthcare providers supporting the setting e.g. sessional GP/ nurse, HSE Social Inclusion in-reach team
    - Identify any linked healthcare provider (including HSE primary care or social inclusion in-reach team), documenting organisation, role and contact details.
- Obtain details of accommodation centre staff, and any visiting/volunteer staff during the incubation period and ensure contact details are recorded.
- Further advice on the roles and responsibilities of centre managers is available in the **International Protection Accommodation Service (IPAS) Infectious Disease Protocol** and Ukraine Crisis Temporary Accommodation Team (UCTAT) Infectious Disease Protocol.
- Advice for centre managers on cleaning, ventilation and laundry is provided in **Appendix 3** limiting the spread of respiratory-borne infections, including measles.

Contacts

Identify vulnerable contacts and determine susceptibility to measles

- **Urgently identify** any vulnerable individuals (residents/ staff) in the setting: pregnant women, children aged under 12 months and immunocompromised people.
- Establish how an urgent **clinical assessment** or **testing** will be undertaken if required, including for any pregnant women, children aged under 12 months and immunocompromised people who are considered contacts.
- Consider urgent measles immunoglobulin G (IgG) testing of any vulnerable contacts ahead of confirmation of diagnosis of the index case (see **Chapter 2, Section 2.2.3.2**)
- **Urgently identify** any linked settings for case and contacts; in particular, child-care/ playgroups, educational or healthcare settings and transport to / from these
    - Consider advising Centre Management (and the respective authority e.g. IPAS, UCTAT, **Irish Refugee Protection Programme** (IRPP), homeless services) that there should be suspension of movements/relocation of other residents (no transfers in or out of the accommodation setting), with a priority on suspending movement of residents to settings

accommodating people who may be at greater risk from measles infection (children under 12 months, pregnant women and immunocompromised people):

- An exception to this is to consider moving susceptible residents who may be at greater risk by acquiring measles infection in the case/outbreak setting, due to a significant individual risk to them (for example an immunocompromised individual in an accommodation setting with an escalating measles outbreak).
- Other considerations may mean that transfers should continue, but this should be done alongside information about the current risks within the index setting, and clear public health advice regarding isolation and other protective behaviours.

Resident contacts

Consider advising isolation for close contacts of a confirmed or suspected case where you cannot confirm whether the contacts have been fully vaccinated or have immunity from previous measles exposure infection.

Issues identifying close contacts:

- As outlined in **Section 2.2.2.2** of this guidance, where it is difficult to identify close contacts (for example, reception tents, boats, transfer coaches), a '**warn and inform**' letter should be given to all those staying in the same setting (where possible), with appropriate translations.
- A low threshold for referral for clinical assessment and testing should be considered for symptomatic individuals, and restriction of their contact with others is advised.

Staff contacts

Where staff have been exposed to a confirmed or suspected case of measles:

- If they are tested rapidly after exposure, they can continue to work if found to be measles IgG positive within 7 days of first exposure (as this is too early to be due to infection from the recent exposure)
- For a **single exposure**, staff exposed to a confirmed or suspected case, who do not have satisfactory evidence of measles immunity, should be excluded from work from 5 days to 21 days after the exposure. In the event of **continuous or multiple exposures**, to a confirmed or suspected case, staff who do not have satisfactory evidence of measles immunity, should be excluded from work from 5 days after the first exposure to 21 days after the final exposure.
- A shorter exclusion period of 14 days may be considered based on a public health risk assessment if staffing levels might lead to concerns for safety of individuals in the accommodation setting. For example, if MMR PEP was given within 72 hours post-exposure, and the staff member remains symptom-free for at least 14 days after the **final exposure.**

Communication

- Send translated letters to cases (or parents of a child case) explaining the diagnosis, the requirement and timeframe for isolation period for the case and for quarantine for contacts.
- Where a confirmed measles case is identified, ensure the local health system is aware of the situation including GPs, out of hours GP providers and local hospital EDs.
- If arranging an immunisation intervention, ensure that a translated consent form is used as necessary.
- Ensure **a factsheet** translated into the appropriate language is provided to all cases and contacts (see also NSIO **Multi-lingual Resources and Translated material** webpage).
- Inform and seek advice from public health team communications officer.
- Communicate with the any schools that the case or contacts may attend.

Vaccination

- The timely deployment of MMR vaccination is crucial in halting measles outbreaks among vulnerable populations in congregate accommodation settings. MMR vaccine, if administered as post-exposure prophylaxis within 72 hours of initial exposure, can potentially prevent or modify the clinical course of measles among susceptible persons (3). The decision to deploy outbreak response vaccination should be made at the IMT.
- Public Health will work with relevant local and regional partners to support vaccine delivery. Approaches to delivery of MMR vaccination in response to a case/outbreak of measles in congregate settings may include:
    - Via the person's GP (if they have a named GP), with reimbursement for the vaccine cost via PCRS with an outbreak code (obtainable from local Public Health). Due to challenges in GP capacity issues nationally, a large proportion of residents in congregate settings may not have a named GP.
    - Sessional GP providing GP clinics within the Accommodation Centre (or Practice Nurse). In many HSE areas, these GP sessions are infrequent and may not have nursing staff supporting the sessions that could assist with vaccination.
    - HSE Vaccination Teams that deliver the Beneficiary of Temporary Protection (BOTP)/ International Protection Applicant (IPA) Catch-up Vaccination Programme, in the Accommodation Centre, with MMR given on public health advice (either prescribed by a Public Health doctor or via Medicine Protocol).
    - HSE National Ambulance Service (NAS) Emerging Threats Team, in the Accommodation Centre, as per the NAS Protocol for the provision of urgent testing and/or vaccination services in the event of a case or an outbreak of specified

infectious diseases in congregate accommodation setting(s)", with MMR given on public health advice.
    - Safetynet Primary Care outreach team, in the Accommodation Centre (following discussion with National Social Inclusion Office NSIO Public Health Team, as outbreak response by Safetynet is covered under their service-level agreement with the National Social Inclusion Office (NSIO).
    - And/or a combination of the above.
- Advise a quarantine period (and suspension of transfers) post-vaccination (from the date of MMR vaccine receipt if date of exposure cannot be determined) to avoid transmission of measles by people who were already incubating measles at the time that they were vaccinated
- Recommend keeping records of administered vaccinations, consider providing written proof of vaccination to individuals not registered with a GP.

Roles and responsibilities

The response to a suspected/confirmed case of measles in congregate accommodation settings for refugees and applicants seeking protection or people who are homeless is led by Public Health (Medical Officer of Health) and supported by stakeholders including:

- HSE Social Inclusion in-reach team
- local GP services
- accommodation centre managers
- the respective Department of Children, Equality, Disability, Integration and Youth (DCEDIY) team (IPAS for IPA and UCTAT for BOTP) or homeless service provider.

The roles and responsibilities for accommodation managers, public health and these other actors for are outlined in the **IPAS protocol** and UCTAT protocols for Infectious Disease (Public Health).

3.1.2 Measles in prisons and places of detention

This guidance provides operational recommendations to assist staff, such as the Irish Prison Service (IPS) National Infection Control Team (NICT) and other stakeholders if an incident or outbreak of measles is reported in a prison or other place of detention (PPD). Operational practice may vary due to setting specific considerations.

The following establishments[e] in Ireland are included within the definition of PPDs used in this guidance:

- Prisons
- The Young Offenders Institute at Oberstown

Vaccination

All residents entering PPD settings should have their vaccination history checked as part of reception screening. Those with an unknown or incomplete history of measles, mumps and rubella (MMR) vaccination should be offered MMR vaccination following national guidance. Staff should be encouraged to be aware of their MMR status, and to get vaccinated where appropriate.

Management of single cases

If an individual in a PPD is suspected to have measles they should be assessed by a clinical member of staff (usually the on-site sessional GP) and rapidly isolated away from vulnerable and unvaccinated residents and staff. Steps should be taken to ensure the welfare of those who are isolated. The regional public health team and /or the IPS National Infection Control Team must be notified if the clinician suspects measles and will support with public health management of the case, close contacts and wider risk assessment (see **Section 2.1**) including advising on appropriate testing (**Section 2.1.1**). An incident management team (IMT) is likely to be convened to guide the response to a single case of measles.

The following should be considered:

- Standard Infection Prevention and Control (IPC) precautions should be implemented by all healthcare and operational staff including appropriate use of personal protective equipment (PPE), refer to **Appendix 4** for details on IPC guidance.
- The individual should be isolated in a single room with a window that can open, and with toilet facilities (where possible) and the door to the room should remain closed.

[e] The Young Offenders Institute at Oberstown does not fall under the remit of Irish Prison Services, it is governed by a board of managers appointed by the Department of Children, Equality, Disability, Integration and Youth. While the principles of managing a single case or outbreak of measles as outlined in this section is likely to be applicable, the IPS national infection prevention and control team would not be involved.

- A risk assessment should be conducted if in-room cleaning and disinfection is not available, or there are other competing risks that make complete isolation inappropriate.
- The impact of complete isolation on an individual's physical, mental health and wellbeing needs to be considered.
- Risk assessment by the healthcare team, with support from regional Public Health Teams should be undertaken to consider continued contact with individuals with known immunity to measles (for example, a roommate or member of staff who has a documented history of two doses of MMR).
- Access to showers, food, medicine and outdoor exercise should be included in the risk assessment. The Public Health team can assist with such risk assessments.
- For management of pregnant cases among individuals in PPDs including staff refer to **Section 2.2.4.2**.

The need for isolation must be carefully explained to the person with suspected measles, including the nature of the infection, the mode of spread, advice on IPC precautions, and its significance for the individual.

Confirmed and suspected cases should be isolated for the duration of the infectious period which extends to the end of 4 full days after rash erupts. Individuals who are immunocompromised may be infectious for longer and may not display typical symptoms. In this instance the timing of isolation should be adjusted as appropriate in consultation with clinicians managing the case.
The clinical needs of the affected individual should be closely monitored, with clinical assessment as needed, and referral/ admission to a hospital, if this is required for clinical care. Refer to **Section 3.2.2** for information on informing the receiving facility in advance.

Contact tracing

Contact tracing should consider the whole infectious period, which is considered to span from four days prior to rash onset to four full days after rash erupts.

Contact tracing should be undertaken to identify individuals (including residents, staff, Prison Service Escort Corp (PSEC) and professional and domestic visitors) who have been in close contact with the case (see **Section 2.2**), with a particular emphasis on identifying all vulnerable contacts (see **Section 2.2.1**) who may be eligible for post exposure prophylaxis (PEP). The Public Health Team will support the setting with this risk assessment. Unvaccinated close contacts of cases are at high risk of developing measles. MMR vaccine given within 72 hours of exposure may reduce the risk of measles infection and a timely offer should be prioritised. Exposed, susceptible individuals should avoid contact with vulnerable individuals (**Section 2.2.1**) and a risk assessment should be conducted to agree the extent of isolation/cohorting necessary for these contacts.

- If staff are tested rapidly after exposure, they can continue to work if found to be measles IgG positive within 7 days of first exposure (as this is too early to be due to infection from the recent exposure).
- For a **single exposure**, staff exposed to a confirmed or suspected case and who do not have satisfactory evidence of measles immunity should be excluded from work from 5 days to 21 days after the exposure. In the event of **continuous or multiple exposures**, to a confirmed or suspected case, staff who do not have satisfactory evidence of measles immunity should be excluded from work from 5 days after the first exposure to 21 days after the final exposure.
- A shorter exclusion period of 14 days may be considered based on a public health risk assessment if staffing levels might lead to concerns for safety of individuals in the setting. For example, if MMR PEP was given within 72 hours post-exposure, and the staff member remains symptom-free for at least 14 days after the final exposure.

If large numbers of contacts, staff or residents, are identified then options for deployment of mass vaccination are detailed in **Section 3.1.1** above.

Given the risk of further cases, all vulnerable individuals in the relevant PPD should be identified, even if not yet exposed, so that their status can be assessed, and steps taken to reduce the risk of future exposure. This should include staff and residents, and careful consideration is required where Mother and Baby Units are part of the setting (**Section 2.2**).
If a case or contact is due to attend a healthcare setting, for example an outpatient setting or emergency department, the setting and the IPC lead should be informed ahead, if possible, to support risk assessment, and if attendance is considered necessary, to ensure appropriate measures are in place to minimise risk; see **Appendix 5**.

Courts and custody

If a suspected or confirmed case, or an exposed, susceptible, and therefore potentially infectious contact, is due in court, a risk assessment should be undertaken. Consider rescheduling the appearance or proceed via video link with clear IPC measures in place. A case who is currently isolating should be provided with a medical ‘sick note’ by the sessional GP. PPDs will have an agreed procedure with court services for managing such cases.

Informing other residents and staff

Where an individual has been identified as having measles, warn and inform information should be provided to other residents and staff, including those in shared residential, education or work settings. The confidentiality of the case/s should be maintained.

Visitors

Information and advice should be readily available for individuals (domestic and professional) visiting the detained setting, including crèche or other support settings such as play areas and visitor centres. Visitors should be reminded not to attend the setting if they have a rash or feel unwell. Use posters and appropriate materials in waiting rooms; see HPSC website **here**. Warn and inform information should be provided to contacts. Consideration should be given to suspending visits during the period of an outbreak

Outbreaks in PPD

In the event of 2 or more cases being identified which are linked by time and place, with the second case occurring within 7 to 21 days of the first, the local Public Health team will convene and lead an urgent Outbreak Control Team (OCT) to advise on actions and next steps. For outbreaks in prisons, the IPS National Infection Control Team should be contacted on: **icct@irishprisons.ie.** For outbreaks in the Young Offenders Institute at Oberstown, institutional management will work with the local public health team to control the outbreak. The OCT may consider vaccination and isolation of staff and residents.

3.1.3 Other residential settings that may present additional complexity in the management of measles

Additional support in managing a case or outbreak of measles (e.g. liaison with families, on-the-ground support, and dissemination of information) at a Traveller halting site (See **Appendix 3** for further description) may be obtained through the **Traveller Health infrastructure**:

- **Primary Healthcare for Travellers Projects (PHCTPs)** are partnership projects between the HSE and Traveller organisations that provide support for Traveller families on the ground and act as an interface between mainstream health services and Travellers. They are a peer-led model that train Travellers to work as **Community Health Workers (CHWs)**.
- Regional **Traveller Health Units (THUs)** operate in each CHO area and work in partnership with local Traveller organisations. The THU Coordinator is a member of the local HSE Social Inclusion team. The THUs are the mechanism for bringing together the local PHCTPs.

Temporary non-standard accommodation

These may be vulnerable migrants, people who are homeless, or members of the Traveller community living in an unauthorised encampment (tents or other temporary structures) on private or public land (including highway verges and lay-bys). Identification and subsequent management of contacts in this instance may be challenging. Local public health teams may be able to avail of support from outreach homeless services, outreach primary care services (e.g. Safetynet Primary Care), or local HSE Social Inclusion teams in responding to a case of measles in these settings.

Other Congregate settings e.g. Tourist accommodation

Elements of the approach outlined in the document may also be applicable to other congregate living settings, for example tourist accommodation, university halls of residence, military barracks or homes of religious orders, but the challenges referred to above are not anticipated to be as commonly encountered in these settings.

Resources:

Translated health resources

Arranging interpreters or translations

IPAS Infectious Disease Protocol (Public Health)

3.2 Measles in Healthcare Settings

3.2.1 IPC Principles for Healthcare settings

More detail on infection prevention and control measures for measles in healthcare settings may be found at:

- **HSE AMRIC Infection prevention and control (IPC) precautions for measles in healthcare settings** and
- **National Clinical Guideline No 30 - Infection Prevention and Control** (Please see **Appendix 4** for a quick reference guide to relevant sections of the NCEC guidance).

3.2.1 Considerations for Healthcare Staff

Ensure staff are measles immune before exposure occurs.
Proactive work should be conducted to ascertain the immune status of healthcare staff in advance of measles outbreaks, as this saves considerable time and resources for healthcare facilities. All health care workers (HCWs), both clinical and non-clinical, who have direct patient contact should be immune to measles.
This applies to roles in which work requires face to face contact with patients; or normal work location is in a clinical area such as a ward, emergency department or outpatient clinic; or work frequently requires them to attend clinical areas.
According to NIAC, acceptable presumptive evidence of immunity against measles includes at least one of the following:

- Written documentation of vaccination with two doses of MMR vaccine at least 28 days apart.
- Serological evidence of measles immunity (i.e., detectable measles specific IgG from an INAB accredited laboratory or equivalent[f])
- Birth in Ireland before 1978. Most adults born in Ireland before 1978 are likely to have had measles infection. MMR vaccine should be offered to such individuals on request if they are considered at high risk of exposure. Presumptive immunity by birth before 1978 should not be used to confirm immunity in those identified as close contacts with a measles case.

All HCWs born outside of Ireland (regardless of age) or born in Ireland during or after 1978 without evidence of two doses of MMR vaccine or measles immunity should be offered one or two doses of MMR vaccine as required at least 28 days apart so that a total of two doses are received.

[f] Acceptable laboratories to be determined by local occupational health and/or public health teams. Only international laboratories that are accredited to the same international standard (ISO15189) as INAB should be accepted

3.2.2 Primary Care

Phone contact

Ideally the suspected case will phone ahead before attending a healthcare setting as advised on the **HSE website**. The **GP screening tool** can be used to screen this call). Receptionists should know that any patients with fever and rash are potentially infectious and, ideally, should arrange an appointment for the patient in a way that minimises the risk of transmission. Options for this could include:

- Remote consultation (as appropriate)
- Schedule appointment at end of day (as appropriate) to reduce waiting times in reception areas and avoid cross-over of infectious and non-infectious patients.
- Patient to remain in the car and be reviewed by the GP there.

Walk-in patient

Whenever possible, signs should be placed in GP surgery waiting areas, advising patients with any rash illness to report to reception. Patients attending without prior notice should ideally be screened and triaged at the reception or entrance (GP/ED). Where patients with a fever and rash attend when other patients are in the waiting room, they should be either be asked to wait in their car and contact the facility on the phone or be directed to a side room. This room should not be used for two hours after the patient has left.

Public Health follow-up

When a suspected case of measles is reported from primary care, the regional public health team is responsible for undertaking the public health risk assessment, identifying all the likely settings where vulnerable individuals may have been exposed.

The regional Public Health team will be able to advise on IPC measures. If the patient was not isolated on arrival to a primary care setting and other patients in the waiting room were exposed, the surgery will be expected to identify susceptible and vulnerable patients (and anyone accompanying them) and staff, and clinically assess the risk to each, based on their vaccine history and underlying condition or treatment.

The regional Public Health team will support these assessments and advise on post-exposure measures as per current guidelines. The majority of exposed individuals will be assessed as low risk, either because they are healthy or already protected through MMR vaccination or previous infection and will simply require a warn-and-inform message from the surgery. A small number of vulnerable contacts may be at risk of serious measles infection, and the regional public health team will advise on required post-exposure prophylaxis for these contacts.

Referral to hospital

When a GP refers a suspected measles case to hospital, they should inform the hospital staff ahead of time, so that the case can be appropriately isolated on arrival: refer to **HSE AMRIC Infection prevention and control (IPC) precautions for measles in healthcare settings** for relevant advice. The hospital should provide the GP with a phone number that the patient can call when they arrive outside. The patient should be advised to avoid close contact with others as far as possible and not to enter the hospital without phoning the given number and confirming staff are happy for them to enter.

3.2.3 Hospital settings

Suspected measles cases that are hospitalised (for example admitted to wards or managed in the ED) need to be appropriately isolated. Rapid identification and isolation of patients are key preventive measures, along with the appropriate choice of personal protective equipment (PPE) following a **point of care risk assessment (PCRA)**. Healthcare facilities should have a priority access pathway to an appropriate isolation room as part of standard procedures for managing known or suspected cases of measles to limit exposure risks. An incident management team (IMT) should be convened in the event of a single confirmed (or highly suspect) measles case in a healthcare setting, as many exposed individuals may be identified. As part of the incident management process, the hospital Infection Prevention and Control Team (IPCT) should be informed of all suspected measles cases in their healthcare facility so that they can undertake a risk assessment and provide appropriate advice, in close cooperation with the regional Public Health team.

The IMT will advise hospital settings on contact tracing and management for hospital contacts, in line with local governance structures including:

- Assessing the exposure and immune status of inpatients, with particular attention to identifying and managing immunocompromised and vulnerable contacts, who may be suitable for PEP.
- Identifying and managing contacts exposed in the hospital setting who are now in the community (this includes patients discharged from hospital to the community).
- Assessing the immune status of HCW's identified as contacts and arranging PEP as appropriate

Staff exposed to measles

- If HCWs are tested rapidly after exposure, they can continue to work if found to be measles IgG positive within 7 days of exposure (as this is too early to be due to infection from the recent exposure).
- HCWs who have documented evidence of receiving only one dose of MMR (or other measles containing vaccine) prior to exposure, should undergo testing for measles IgG within 7 days of exposure and receive a second MMR ideally within 72 hours of exposure. They should be excluded from work until IgG result is available, and if positive, they can return to work.
- HCWs with satisfactory evidence of protection can continue to work normally but should be advised to self-isolate, seek medical advice, inform their line manager and Occupational Health (OH) if they develop prodromal symptoms or a fever between 7 days after the first exposure and 21 days after the last exposure. Exposed HCWs that develop fever, or rash should be excluded from all work until 4 full days after rash erupts and until illness resolves. Those HCWs should be treated as a probable case and laboratory confirmation and notification should be sought in the usual way.
- For a single exposure to a confirmed or suspected case, HCWs who do **not** have satisfactory evidence of measles immunity should be excluded from work from 5 days to 21 days after the exposure, regardless of whether they have received post-exposure MMR vaccine. In the event of continuous or multiple exposures, to a confirmed or suspected case, staff who do **not** have satisfactory evidence of measles immunity should be excluded from work from 5 days after the first exposure to 21 days after the final exposure, regardless of whether they have received post-exposure MMR vaccine.
- Staff who receive post-exposure immunoglobulin should also be excluded from work from the 5th day after the first exposure to 21 days after the final exposure but should self-monitor for symptoms up to 28 days post-exposure.
- Staff who become ill should be removed from all patient contact and excluded from work for 4 full days after the rash erupts and until illness resolves.
- Where staffing levels due to exclusion from work, lead to concerns for patient safety the risk assessment should be reviewed by the IMT/OCT (which may[g] include representation from Occupational Health if available).
- Considerations for contact tracing through 'warn and inform' messages

When detailed information on the health and immune status of contacts is difficult to obtain (for example patients exposed in an emergency department waiting rooms), attempting to obtain detailed medical information on a large number of individuals at low risk could lead to unnecessary delay. In these situations, contact tracing through mass messaging (for example by email, text, HSE Live,

[g] **Occupational Health representatives** will not be available during weekends or outside of regular working hours. Therefore, **the decision to review the risk assessment should not be postponed until working hours**.

media alerts or letter) should be considered. This would involve the IMT identifying all individuals who were potentially exposed to the index case and providing information (for example, by using a link to a web page) about measles and advising individuals who may be vulnerable to seek medical advice. Similarly, this approach can be used by Public Health to contact large groups of individuals who may all have been exposed in the community, and for whom contact details exist (for example, passengers on a coach).

Further considerations for hospitals experiencing a measles outbreak

- All elective admissions to an institution associated with a current measles outbreak should as far as possible be age-appropriately immunised prior to admission – preferably with two doses of MMR. Ideally, people on the waiting lists should be written to and informed of this recommendation prior to admission by letter/phone call.
- Urgent admissions should never be delayed on the basis of vaccination status.
- There is no evidence that any effects of immunisation have an impact on outcomes of either anaesthesia or surgery. Urgent or emergency surgery should never be delayed because of recent vaccination.
- People not known to be immune to measles who require admission should be offered MMR vaccination if there are no contra-indications.
- All long-term patients born during or after 1978 attending the health care facility should have their immunisation status checked and be offered MMR vaccination if necessary.

3.3 Measles in Educational and Childcare Facilities

Confirmed and suspect cases should be excluded from childcare facility or school for the infectious period (from 4 days before rash onset and for a further 4 full days after rash erupts). Given the high risk of secondary infection following measles, it is advisable to return to the childcare facility or school only when post infectious and after full recovery from measles illness. Susceptible contacts of cases (for example unvaccinated siblings) are at high risk of developing measles and should be advised to self-exclude from school for the duration of the incubation period. They should stay out of school from the 5th day after the first exposure to 21 days after the end of the case's infectious period. This is to avoid transmitting measles to other children in the school. Schools should be asked whether they are aware of any vulnerable students or teachers, even if not yet exposed, so that their status can be assessed, and steps taken to reduce the risk of future exposure.

3.3.1 Control of measles outbreaks in schools

Measles outbreaks are unlikely to occur in schools with high uptake of two doses of MMR among the school population. Recommendations:

- All school children who are in senior infants or older should already have two doses of MMR.
- Schools should make parents aware that measles can be prevented with two doses of MMR.
- In the event of an outbreak in a school any child without documented evidence of two doses of MMR vaccine should urgently complete the two-dose schedule of MMR (the second dose given at least 28 days after the first MMR).
- All staff, who do not have documented evidence of 2 doses of MMR also should be vaccinated with MMR.

3.3.2 Control of measles outbreaks in a childcare facility

- Following notification of a possible measles case in a childcare facility a risk assessment should be undertaken.
- If risk assessment indicates low risk, e.g. unlikely to be a measles case, consider issuing a letter to parents recommending age-appropriate MMR vaccination while awaiting swab results.
- If risk assessment indicates high risk, e.g. confirmed or highly suspicious case, or an outbreak situation, the following actions should be considered.
    - Vaccination with MMR is recommended for all those attending the facility, and their siblings, who are older than one year of age and have not received two doses of MMR. Any second dose of MMR should be administered at least 28 days post administration of the first dose.

- A single dose of MMR vaccine may be given to attendees or siblings of attendees aged 6 to 11 months on the advice from the regional Public Health team. Children vaccinated before their first birthday should have a repeat vaccination at 12 months of age, at least one month after the first vaccine with a further dose at 4-5 years of age.
- All staff who do not have documented evidence of 2 does of MMR also should be vaccinated with MMR.

In some instances, unvaccinated contacts of a confirmed case of measles in educational and childcare facilities will be requested to stay home from childcare facility or school for the duration of the incubation period. This decision would be taken by the regional Public Health team after a public health risk assessment, considering the details of the case, and decisions may evolve in response to changing nature of the incident.

The guiding principles in this decision are:

- Protection of most vulnerable
- Prevention of further cases
- Maximisation of access to education

Considerations to inform this risk assessment include:

- Infectiousness of the index case
- Nature of the exposure
  - IPC in school: hand hygiene and ventilation
  - School classroom lay-out
  - Movement of children between classes and through the school
  - Shared school transport
- Contacts' characteristics

If a school with an ongoing measles outbreak is planning a school trip, all students who are not vaccinated or incompletely vaccinated should be vaccinated at least 2 weeks prior to departure with 2 doses MMR at least 4 weeks apart. Similar considerations apply to students about to go on work placements, particularly in health care settings or with vulnerable patients.

More detailed information about IPC in school settings can be found in the **HPSC Guidance on management of infectious diseases in schools** and **Management of Infectious Diseases in Childcare Facilities/Settings**.

3.4 International travel

All suspected or confirmed measles cases linked to international travel, or who have travelled on aircrafts should be notified by to Ireland's International Health Regulations (IHR) National Focal Point (NFP) Health Protection Surveillance Centre (HPSC), contactable by email through the on-call team at the HPSC at **healthprotectionhpsc@hpsc.ie**

For probable or confirmed cases who were infectious whilst abroad in a non-endemic country, or who are likely to have acquired their infection in a non-endemic country, contact with the relevant IHR NFP should be made by Ireland' IHR NFP at HPSC. In any event, suspect/confirmed cases known during a flight or sea transport should always be referenced in the respective Aircraft/Maritime Declarations of Health. These documents should always accompany all such international means of travel.

Reporting of cases linked to international travel is an essential part of international surveillance and reporting should not be limited only to cases where immediate post-exposure interventions can be conducted. Classification of imported cases and identifying international links between cases is an important component of regional and global elimination and would be expected by most other countries.

3.4.1 Air travel

For a probable or confirmed case of measles who has travelled internationally during the infectious period, a risk assessment should be undertaken. The regional Public Health team should, on a case-by-case basis and in particular where post exposure prophylaxis may be possible, arrange that 'warn and inform information' is sent to all passengers and crew considered to be potential contacts. Depending on the circumstances, regional Public Health teams may liaise with the affected airline to request that the airline contact all passengers and crew on the relevant flight, or they may contact the airline to obtain the flight manifest and contact passengers and crew directly. This communication should inform the recipient of exposure to confirmed measles case on the flight and advise them to review the linked information regarding their risk. A standard information leaflet for flight contacts is available on the HPSC website. Please see **here**.

3.4.2 Other modes of transport

For probable or confirmed cases of measles linked to travel other than by air during the infectious period, sending 'warn and inform information' through the transport provider should be considered. If the transport provider does not have contact details of passengers, no further action is required If a

defined group is known (for example, children on a school trip, passengers on a specific bus), and can be contacted through other means (e.g. media alert) consideration can be given to issuing warn and inform information

3.5 Outbreaks

An outbreak is defined as 2 or more epidemiologically linked cases (linked in Time, Person, Place) that occur within one incubation period of each other (that is the second case occurs between 7 and 21 days of the first case) (4). Outbreaks may be confined to some of the members of one household or may be more widespread and involve cases either locally, nationally or internationally.

3.5.1 Outbreaks planning and response

Regional Public Health teams should work with their local health service colleagues to ensure that the necessary resources are available within their area to manage the response to outbreaks. Regional Public Health Teams should know how to arrange access to urgent laboratory testing services (particularly measles IgG and PCR), outbreak-response vaccination (e.g. via local immunisation teams or the NAS), and be familiar with PEP-HNIG pathways in local hospitals.

While most outbreaks occur within the household setting, an outbreak control team (OCT) should be convened when transmission has occurred in other settings where a number of people have been exposed (for example, school outbreak) or where the population exposed may be more vulnerable (for example hospital outbreak). If the reported number of measles cases across a local area or community is above the expected level, an OCT should be considered to identify common factors and implement control measures. Membership of the OCT should be relevant to the scale and impact of the outbreak and the setting. For outbreaks related to healthcare settings, refer to **National Clinical Guideline No 30 - Infection Prevention and Control, Volume 1 section 3.4.2, Outbreak investigation and management**.

Hospital outbreaks or clusters will require close liaison with key stakeholders from hospital infection prevention and control, hospital management structures, Occupational Health, as well as the regional Public Health team. Suggested OCT membership for a healthcare facility outbreak is listed in **National Clinical Guideline Chapter 30, section 3.4.2 Table 20 Outbreak investigation and management**.

When outbreaks occur in an institutional setting such as a school, university, place of detention or congregate setting all individuals in the setting who are susceptible or incompletely vaccinated should be offered MMR vaccine promptly, even if direct contact with the index case has not occurred.

Appendices

Appendix 1 - Measles Guideline Development Group Membership

Name	Role	Organisation
Lois O' Connor (Chair)	Consultant in Public Health Medicine	HSE Public Health: National Health Protection Office
Aidan Ryan	Consultant in Public Health Medicine	HSE Public Health, West and Northwest
Aileen Kitching	Consultant in Public Health Medicine, Public Health Lead for Social Inclusion	HSE National Social Inclusion Office
Alida Fe Talento	Consultant Microbiologist, Children's Health Ireland	Children's Health Ireland
Andrea King	Assistant Director of Nursing	HSE Public Health, Dublin and Midlands
Ashwin Delmonte Sen	Inclusion Health Consultant (Infectious Disease specialist)	Tallaght University hospital
Barbara Slevin	Assistant Director of Nursing, Antimicrobial Resistance Infection Control, AMRIC	HSE Office of the Chief Clinical Officer
Breda Cosgrove	Consultant in Public Health Medicine	HSE Public Health, Mid-West
Ciara Martin	National Clinical Advisor and Group Lead for Children and Young People	HSE Office of the Chief Clinical Officer
Cillian De Gascun	Consultant Medical Virologist and Laboratory Director	National Virus Reference Laboratory, University College Dublin
Claire Gilbourne	Health Protection Researcher	Research and Guideline Development Unit, National Health Protection Office
Deborah Moriarty	Rehabilitation Lead Occupational Health	HSE Workplace Health & Wellbeing
Elaine Dunne	National Infection Control Team	Irish Prison Services
Elizabeth Trautt	Consultant Microbiologist	Irish Society of Clinical Microbiologists
Ellen Martin	Senior Antimicrobial Pharmacist AMRIC	HSE Office of the Chief Clinical Officer
Emmett Conroy	Irish Prison Services	Irish Prison Services
Grainne Larkin	Senior Medical Officer	HSE Public Health, Dublin Midlands
Helen Cooper	Specialist Registrar in Public Health Medicine	HSE Public Health, West and Northwest
Julie Lucey	Consultant Paediatrician S/I Infectious Diseases	University Hospital Waterford
Liam Philips	Irish Prison Services	Irish Prison Services
Louise Lyons Mehl	Senior Medical Officer	HSE National Immunisation Office
Mary Ward	Consultant in Public Health Medicine	HSE Public Health, Dublin and Midlands
Padraig McGettrick	Consultant Infectious Diseases	The Mater Hospital, Mater Misericordiae University Hospital
Paul Mullane	Consultant in Public Health Medicine	HSE Public Health, Dublin and Northeast
Randal Parlour	Research and Guideline Development Unit Coordinator	Research and Guideline Development Unit, HSE National Health Protection Office
Sarah Gee	Senior Epidemiologist	HSE Health Protection Surveillance Centre
Scott Walkin	Antimicrobial Resistance & Infection Control Clinical Lead	Irish College of GPs
Tessa O' Gorman	Specialist Registrar in Public Health Medicine	HSE Public Health, Southwest

Appendix 2 - Differential Diagnoses

Roseola (exanthema subitum, sixth disease)

Pathogen

Human herpesvirus 6 (HHV6), occasionally HHV7.

Clinical presentation

Generally mild, often asymptomatic. When symptomatic, illness starts with 3 to 5 days of fever, which might be followed by a maculopapular rash, although most children have a viral illness without rash. Unlike measles, the onset of rash occurs when patients improve clinically and the fever recedes.

Epidemiology and transmission

Most infections occur in children aged 6 to 24 months. Transmission occurs through the respiratory route or droplet transmission. Seroprevalence studies have shown that by 2 years of age 90% of children are immune against HHV6 (20). Cases in older children may be due to HHV7, which tends to be acquired later in life, with seroprevalence studies showing that about
65% of children in the UK are immune by the age of 3 years (21). As HHV6 and HHV7 remain latent after infection, they can therefore reactivate among immunosuppressed individuals later on in life.

Incubation period

Around 5 to 15 days.

Scarlet fever

Pathogen

Group A streptococcus.

Clinical presentation

Sore throat, pharyngeal exudate, high fever. Cough is generally absent. The maculopapular rash typically appears about 12 to 48 hours after the start of symptoms. It generally starts on the abdomen, spreading to neck, back and limbs. A white coating of the tongue may be present (‘strawberry tongue’).

Epidemiology and transmission

Transmission occurs through the respiratory route or droplet transmission. It is most common during winter months or in early spring. Scarlet fever affects mostly children of school and pre-school age.

Incubation period

Around 2 days, ranging from 1 to 5 days (22).

Fifth disease (‘slapped cheek’ syndrome)

Pathogen
Parvovirus B19.

Clinical presentation

The infection generally presents with typical features of ‘slapped cheeks’, followed by a rash which is most visible on the extremities. There may be prodromal symptoms leading to the rash, such as coryza, fever or headache. Arthralgia and arthritis may be present – these are more common among adults.

Epidemiology and transmission

Transmission occurs through the respiratory route or droplet transmission. It is most common during winter months or in early spring. Children of all ages can be affected, and an infection among adults is not uncommon. Secondary attack rates among households and schools is high (23). Transmission occurs in the week preceding the rash and individuals are considered non-infectious when the rash appears.

Incubation period

Around 13 to 18 days (24).

Rubella (German measles)

Pathogen
Rubella virus.

Clinical presentation

Generally mild, asymptomatic in up to 50% of the cases (particularly in children). A prodromal phase of 1 to 5 days may precede the rash, with symptoms of malaise and coryza, with or without fever. Post-auricular and sub-occipital lymphadenopathy may be present. The rash is non-specific, generally mild and is most often seen on the face and behind the ears, where it starts before spreading.

Epidemiology and transmission

Rubella is prevented by MMR vaccination and few cases of rubella are now being reported. Most reported cases are imported.

Incubation period

14 days (range 12 to 21 days) (25).

Infectious mononucleosis (glandular fever)

Pathogen

Mostly Epstein-Barr virus (EBV). Rarely CMV, HHV6, HSV.

Clinical presentation

It mainly presents with a sore throat (pharyngitis or tonsillitis). Malaise and fever are common presentations. A rash only occurs in only about 10% of infected individuals and may not always be maculopapular. A more typical maculopapular rash frequently occurs after starting antibiotic treatment for pharyngitis.

Epidemiology and transmission

EBV is transmitted mostly through direct contact with saliva. About half of infections are asymptomatic but more so in young children than in adolescents and adults.

Incubation period

Thought to be about 30 to 50 days.

Other differential diagnoses to consider

Zika, Dengue, Chikungunya, primary HIV infection and syphilis.

Appendix 3: Congregate settings for underserved population in Ireland

These include:

- State-provided accommodation for international protection applicants (IPA) or people 'seeking asylum', the responsibility of International Protection Accommodation Services (IPAS) in the Department of Children, Equality, Disability, Integration and Youth (DCEDIY)
- State-provided accommodation for beneficiaries of temporary protection (BOTP) fleeing war in Ukraine, the responsibility of the Ukraine Crisis Temporary Accommodation Team (UCTAT) in the DCEDIY
- State-provided accommodation for refugees, in Reception and Orientation Centres (ROCs) or ROC places), the responsibility of the Irish Refugee Protection Programme (IRPP) in the DCEDIY
- Accommodation for separated children seeking international protection/ unaccompanied minors, the statutory responsibility of the Child and Family Agency (TÜSLA)
- Emergency accommodation for people who are homeless (e.g. hostels, family hubs, night shelters, domestic abuse refuges).

Challenges common to these populations and/or settings may present additional complexity in the public health response to a case or outbreak of measles. These include:

- Individuals in these settings may be at *risk of exposure to measles* on their transit journey to Ireland, with a high probability of importation of measles between Member States in the EU/EEA[h]
- Individuals in these settings may be *more susceptible to measles* because of under-vaccination, which may be due to – disrupted living conditions before and during their displacement; recently arrived or undocumented migrants who may enter the EU/EEA insufficiently immunised; all populations with difficulties accessing healthcare in Ireland; vaccination not a high priority compared to acute medical needs/ shelter/ education for children; children of families with low vaccine confidence due to religious or personal beliefs or mistrust in authority
- Individuals in these settings may be *more vulnerable to measles* if acquired, due to poorer health, underlying immunosuppression, pregnancy, age (less than 1 year old)

[h] https://www.ecdc.europa.eu/en/publications-data/threat-assessment-brief-measles-rise-eueea-considerations-public-health-response

- Individuals in these settings may be *less able to isolate or take other actions* to prevent the spread of measles
- There is a *higher risk of airborne virus transmission* due to crowding, people sharing rooms, shared facilities, staff/resident turnover, and less adequate ventilation
- There are *challenges implementing isolation and infection prevention and control measures* in these settings, given that the primary function is the provision of accommodation and related supports, rather than responding to a healthcare need
- There may be *challenges identifying case contacts* in these settings, due to the transient nature of accommodation, lack of bed management systems in some IPAS accommodation settings, challenges in getting up-to-date resident lists
- There may be *challenges ascertaining exposure(s) to measles or their timing* if there is a high degree of mixing in the setting, and thus in determining quarantine periods for contacts (usually determined from date of exposure and conservatively based on the maximum incubation period of measles (commonly 21 days is used))
- There may be *language* (requirement for interpreter/translated resources), *literacy* (requirement for 'easy-read'/ NALA-proofing of resources, see HSE Communicating Clearly) and/or *cultural* barriers to understanding
- There is a need for *broader stakeholder engagement in the public health response*, including HSE Social Inclusion, the DCEDIY government department teams (IPAS, UCTAT or IRPP) and non-governmental organisations (e.g. Safetynet Primary Care, agencies providing services for homeless people).

Approaches to management at population level

- Restrictions or suspensions of transfers in/out of the accommodation centre (or part of the centre)
- Proportionate reduction in communal activities in the accommodation centre
- Cohorting: process for temporarily keeping (accommodating) similar groups together and separate from other groups to prevent the spread of infection
    - Cohorting: of residents suspected/confirmed to have measles to reduce the risk of their spreading it to others in the setting
    - Reverse cohorting: of newly received residents to protect them from measles virus, until it can be determined that they: (a) do not present an infection risk themselves, (b) are not susceptible to measles infection (based on MMR or previous measles infection), (c) are not vulnerable to severe consequences if they acquire measles (pregnant, less than 12months old, immunocompromised)
- Isolation: process for the temporary separation of suspected or confirmed measles cases while they are infectious

- Shielding: process for the temporary isolation of people who are vulnerable to the consequences of measles infection if acquired (pregnant, infants<12 months of age, immunocompromised individuals)
- Introduction of IPC and personal protective equipment (PPE) measures being used in the setting (Please see Appendix 4 for direction to relevant section of the National Clinical Guideline No 30 - Infection Prevention and Control)

Limiting the spread of respiratory-borne infections, including measles in Congregate Settings

Ventilation

- Bringing in fresh air to occupied spaces can help to reduce the concentration of respiratory particles, lowering the risk of airborne transmission of measles
- Other mitigation measures should be determined by risk assessment and implemented appropriately.

Principles of cleaning

- Regular cleaning can help reduce the risk of spreading infection. Detergents are adequate for routine cleaning
- Measles virus is spread by contact with infected nasal or throat secretions (coughing or sneezing) or breathing the air that was breathed by someone with measles. Surfaces and belongings can also be contaminated when people with measles cough or sneeze or touch them. The virus remains active and contagious in the air or on contaminated surfaces for up to two hours.
- When a person is known or suspected to have measles infection, adhere to environmental and equipment cleaning and disinfection in accordance with National Clinical Guideline No 30 - Infection Prevention and Control, see section 3.1.3 Routine management of the physical environment, Volume 1, NCEC National Clinical Guideline No. 30 Infection Prevention and Control. Either a 2 step clean - a physical clean using a detergent followed by disinfection with a chlorine-based product such as sodium hypochlorite or another appropriate disinfectant can be used or a two in one clean - a physical clean using a combined detergent and a chlorine-based product such as sodium hypochlorite or another appropriate disinfectant.
- Cleaning and disinfection of frequently touched surfaces is particularly important in bathrooms and communal kitchens.
- As a minimum, frequently touched surfaces such as door handles, light switches, work surfaces, remote controls and electronic devices should be cleaned daily. Cleaning should be more frequent depending on local risk assessment and the number of people using the space, whether they are entering and exiting the setting and access to hand hygiene facilities.
- Suitable hand hygiene facilities should be available including hand washing, Alcohol Based Hand Rub (ABHR), running water, liquid soap and paper towels or hand driers. Hand hygiene

should be performed after removing facemasks or contact with contaminated surfaces or laundry.

Waste

- Waste with respiratory secretions from a person with suspected or confirmed measles should be sealed in a waste bag before removal from the accommodation and placed into a waste bin as soon as possible. There is no need to store waste for a time before collection. Dispose of routine waste as normal.

Laundry

- Appropriate handling and linen assists in reducing transmission (see NCEC National Clinical Guideline No. 30 Infection Prevention and Control Volume 1, sections 3.1.7 and 3.1.8) for further advice. Wash items in accordance with the manufacturer's instructions. Use the warmest water setting and dry items completely. If the area is a healthcare facility, they must have documented policies on the collection, transportation and storage of linen. Where an external laundry provider is used, water-soluble (alginate) bags can be used, where available for contaminated laundry and manage as per local policies. Facilities that process or launder linen must have documented operating policies, note, that alignate bags cannot be used in domestic washing machines).
- To minimise the possibility of dispersing measles virus through the air, do not shake used laundry prior to washing.

Visitors or volunteers

- Visitors or volunteers who are unwell or have prodromal symptoms or rash, fever' should stay at home and not participate in visits. They can participate in visits or volunteering again once their symptoms have resolved, and they are advised that they are no longer infectious.

Other residential settings that may present additional complexity in the management of measles

Complex domestic settings

These are residential settings where people are living in (a) overcrowded accommodation, as defined in the Housing Acts (1966, 1988), or (b) accommodation that is unfit for human habitation or is materially unsuitable for adequate housing, such as substandard private rented accommodation, where standards are set out in the Housing (Standards for Rented Houses) Regulations 2019.These may be settings with large multi-generational families, migrant workers in meat processing plants or mushroom factories, or other vulnerable migrants, including undocumented migrants.

These settings can be managed as per the usual management of household contacts, but additional supports may be required to meet language and literacy needs, to identify contacts etc.

Traveller-specific accommodation (halting sites)

A halting site, also known as a 'Serviced Halting Site' or 'Halting Bay Site', is purpose-built residential accommodation for Travellers, provided by a local authority. Halting sites generally comprise an individual bay for each family unit, which consists of a parking space for a caravan/ mobile home and a smaller house structure (serviced unit) with kitchen, bathroom facilities and other service facilities.[i] A *temporary/ transient halting site* is erected on a temporary basis by a local authority with both serviced and un-serviced bays. On many halting sites, there may be multiple caravans accommodating extended family members, all using a single bay service unit.

These settings can be managed as per the usual management of household contacts, but additional supports may be required to meet language and literacy needs, to identify contacts etc.

[i] https://www.opr.ie/wp-content/uploads/2021/10/Traveller-Accommodation-and-the-Local-Authority-Devlopment-Plan-Case-Study.pdf

Appendix 4: Measles IPC Guidance

This section provides a quick reference guide to assist with identifying relevant guidance within The National Clinical Guidance No. 30 Infection Prevention and Control" available at: https://www.gov.ie/en/publication/a057e-infection-prevention-and-control-ipc/

1. Details on **standard precautions** are contained in the following sections:
    - Volume 1, section 2, No. 2.1.5, page 20
    - Volume 1, section 3, No. 3.1 page 37
    - Volume 2, section 7. No. 7.2 Checklist of PPE typically required for common procedures performed on patients
    - Volume 2, section 7, No.7.3 Use of standard and transmission-based precautions, Table 41.
    - Volume 2, Appendix 7.4, Page 264: Type and duration of precautions for specific infections and conditions,
    - Volume 1, section 3, No. 3.2.1, page 88, Application of transmission-based precautions and relevant sections on:
    - Contact precautions: Volume 1, section 3, No. 3.2.2, page 91
    - Droplet precautions: Volume 1, section 3, No. 3.2.3, page 95
    - Airborne precautions: Volume 1, section 3No. 3.2.4, page 98
    - Strategies for implementing transmission-based precautions: Volume 1, section 2, No. 2.1.9, page 22
2. Sections **on the use of PPE** for standard and transmission-based precautions are available in the following sections:
    - Volume 2, Appendix 7, Section 7.3, page 250 Use of standard and transmission-based precautions, Page 250
    - Volume 2, Appendix 7, Section 7.4, Table 44, page 252 Precautions for specific infections and conditions, including recommendations for the use of Personal Protective Equipment (PPE) for respiratory viral infections
3. Specific recommendations **on correctly fitted and fit checked respiratory protection** (FFP2 respirator) is available in Volume 1, section 3, No. 3.2.4 pages 98-101, Airborne precautions, Recommendation 16.
4. Follow appropriate sequence and procedure for **putting on and removing PPE** as outlined in HSE training materials, see poster section in:
    - https://www.hpsc.ie/a-z/respiratory/coronavirus/novelcoronavirus/posters/
5. For advice on **cleaning and disinfection** of equipment, refer to
    - Volume 1, Section 3, No. 3.2.2 Contact precautions, Recommendation 13: page 94, Single use or patient dedicated equipment.
6. Adhere to **environmental and equipment cleaning** and disinfection in accordance with NCEC guidelines, see section

- 3.1.3 Routine management of the physical environment, Volume 1.
- Waste management: Volume 1, section 3.1.7
- Manage linen in accordance with section 3.1.8 Handling of linen, Volume 1

7. Managing a cluster or **outbreak** of a respiratory viral infection in an Acute Hospital Setting
   - See Volume 1, section 3, No. 3.4.2 page 125, Outbreak investigation and management
8. Resources on Point of care risk assessment; For further information on PCRA and how to use a PCRA please see links
   - https://www.hpsc.ie/a-z/microbiologyantimicrobialresistance/infectioncontrolandhai/posters/
   - https://www.hse.ie/eng/about/who/healthwellbeing/our-priority-programmes/hcai/resources/general/

Appendix 5: IPC Principles for Healthcare settings

The table below sets out key infection prevention and control (IPC) principles required to prevent importation and transmission of measles in healthcare settings.

These measures are relevant for all healthcare care settings and supports prompt identification and management of suspected or confirmed measles cases through effective patient screening, triage and mitigation measures for scheduled and unscheduled care.

Scheduled/ unscheduled care	Type	Mitigation measures
1. Unscheduled care	First contact by phone Examples include: • GP • GP Out of hours (OOH) • Psychiatry services • Emergency ambulance	Phone history taking screening triage undertaken by admin grades GPs/patients/ambulance service should pre-alert the ED about the referral about a possible case of measles. Such patients should be admitted directly to a side room or segregated area See here for sample phone screening tool Promote staff vaccination (& know staff immunity status)
2. Unscheduled care	First contact by walking in Examples include: • GP • GP OOH • psychiatry services • ED • LIU	Posters and instructions Ideally patient goes back to the car/home (as appropriate) & advised to make phone contact with healthcare facility (provide telephone contact number on door). Recommended to phone before entering the facility Remote consultation (as appropriate) Schedule appointment at end of day (as appropriate) to reduce waiting times in reception areas (where necessary) and avoid cross-over of infectious and non-infectious patients Patients attending without prior notification should ideally be screened and triaged at the reception or entrance(GP/ED). Patients attending with suspected measles infection should not wait in communal areas or reception areas and should be prioritised for assessment/treatment. They should be isolated at the time of arrival a

		segregated area (ideally a single room away from others) as soon as possible. Ideally a negative-pressure isolation room with en-suite facilities, if not available, a single room, ideally with en-suite facilities. Promote staff vaccination (& know staff immunity status)
3. Unscheduled care	Via referral Examples include: • ED • MAU • OPD clinics	Mitigation at point of first contact per No.1 and No. 2 above and by referrer pre-alert Promote staff vaccination (& know staff immunity status)
4. Scheduled contact	Examples include: • OPD • Radiology • Day cases • Day treatment • Elective admissions, most hospital contacts. • List below contains some examples and this list is not exhaustive. • Paediatric units • Antenatal clinics • Haematology and oncology units. • Dialysis units • Allied health professional appointments e.g. physio, OT, SLT, dental, dietetics etc.	Mitigation is in advance and included in appointment notification letters, SMS messaging, phone liaison (as appropriate) and by measles alert posters on site Promote staff vaccination (& know staff immunity status)
5. Residential care facilities	Lower risk The majority of residents were born in Ireland prior to 1978 Facilities for younger residents however are more vulnerable	Promote staff & residents' vaccination Know staff & residents immunity status. Manage visitors (manage as per Point 2 in table for unscheduled care. Some principles of the approach used in congregate settings section may be appropriate in some residential care facilities.
6. Others who access healthcare facilities	Examples include: Visitors, accompanying individuals, parents, support partners to healthcare facilities	Manage as per unscheduled care (see point 2 in table)

Bibliography

1. Health Protection Surveillance Centre. Measles in Ireland, 2017. www.hpsc.ie: HSE Health Protection Surveillance Centre, 2018.
2. Health Service Executive Immunisation: MMR Catch-Up Campaign: FAQs for Healthcare Professionals Online HSE 2024 [updated 21/06/2024. Available from: https://www.hse.ie/eng/health/immunisation/hcpinfo/frequentlyaskedquestions/mmrcatchupcampaignfaqshcp.html.
3. NIAC Immunisation Guidelines. Chapter 12. Measles. Online Royal College of Physicians of Ireland. National Immunisation Advisory Committee (NIAC); 2024.
4. UKHSA. National Measles Guidelines. 2024. Online Available from: https://www.gov.uk/government/publications/national-measles-guidelines
5. Brouwers MC, Kho ME, Browman GP, Burgers JS, Cluzeau F, Feder G, et al. AGREE II: advancing guideline development, reporting and evaluation in health care. Cmaj. 2010;182(18):E839-42.
6. Falzarano M, Pinto Zipp G. Seeking consensus through the use of the Delphi technique in health sciences research. J Allied Health. 2013;42(2):99-105.
7. Nair R, Aggarwal R, Khanna D. Methods of formal consensus in classification/diagnostic criteria and guideline development. Semin Arthritis Rheum. 2011;41(2):95-105.
8. Moss WJ, Griffin DE. Measles. The Lancet. 2012;379(9811):153-64.
9. Eliminating measles and rubella and preventing congenital rubella infection. A situational analysis and recommendations. Strategy for Ireland. Department of Health; 2007.
10. WHO. Guide to the documentation and verification of measles and rubella elimination in the WHO Eastern
Mediterranean Region. Online: WHO Regional Office for the Eastern Mediterranean; 2021.
11. WHO. Seventh Meeting of the European Regional Verification Commission for Measles and Rubella Elimination (RVC) 13–15 June 2018 Paris, France. Online: WHO Regional Office for Europe; 2018.
12. WHO. Twelfth meeting of the European Regional Verification Commission for Measles and Rubella Elimination 8–11 September 2023 Copenhagen, Denmark Meeting Report. Online WHO Regional Office for Europe; 2024; 2023.
13. Health Protection Surveillance Centre. Prevalence of measles IgG antibodies in adults aged 18-34 years in Ireland, 2022. Online HSE Health Protection Surveillance Centre 2023.
14. Public Health England, Public Health Agency, Health Protection Scotland Measles and rubella elimination UK strategy. Online; 2019.
15. S.I. No. 390/1981 - Infectious Diseases Regulations 1981, (1981).
16. Bloch AB, Orenstein WA, Ewing WM, Spain WH, Mallison GF, Herrmann KL, et al. Measles outbreak in a pediatric practice: airborne transmission in an office setting. Pediatrics. 1985;75(4):676-83.
17. Ehresmann KR, Hedberg CW, Grimm MB, Norton CA, Macdonald KL, Osterholm MT. An Outbreak Of Measles At An International Sporting Event With Airborne

Transmission In A Domed Stadium. The Journal of Infectious Diseases. 1995;171(3):679-83.
18. Marin M, Nguyen HQ, Langidrik JR, Edwards R, Briand K, Papania MJ, et al. Measles Transmission and Vaccine Effectiveness during a Large Outbreak on a Densely Populated Island: Implications for Vaccination Policy. Clinical Infectious Diseases. 2006;42(3):315-9.
19. CDC. Measles Outbreak Among School-Aged Children - Juneau, Alaska, 1996.
20. WHO. Manual for the laboratory diagnosis of measles and rubella virus infection.: WHO Document Production Services, Geneva, Switzerland; 2007.
21. Perry RT, Halsey NA. The Clinical Significance of Measles: A Review. The Journal of Infectious Diseases. 2004;189(Supplement_1):S4-S16.
22. UKHSA. Green Book (2005). Chapter 21: measles. 2005.
23. Manikkavasagan G, Ramsay M. Protecting infants against measles in England and Wales: a review. Archives of Disease in Childhood. 2009;94(9):681-5.
24. Campbell H, Andrews N, Brown KE, Miller E. Review of the effect of measles vaccination on the epidemiology of SSPE. International Journal of Epidemiology. 2007;36(6):1334-48.
25. Campbell H, Lopez Bernal J, Bukasa A, Andrews N, Baker E, Maunder P, et al. A Re-emergence of Subacute Sclerosing Panencephalitis in the United Kingdom. The Pediatric Infectious Disease Journal. 2023;42(1):82-4.
26. Manikkavasagan G, Ramsay M. The rationale for the use of measles post-exposure prophylaxis in pregnant women: a review. J Obstet Gynaecol. 2009;29(7):572-5.
27. NIAC Immunisation Guidelines. Chapter 3. Immunisation of Immuncompromised Persons Online Royal College of Physicians of Ireland. National Immunisation Advisory Committee (NIAC); 2023.
28. Hope K, Boyd R, Conaty S, Maywood P. Measles transmission in health care waiting rooms: implications for public health response. Western Pac Surveill Response J. 2012;3(4):33-8.
29. UCD National Virus Reference Laboratory User Manual and Pathogen Index. UCD – National Virus Reference Laboratory; 2023.
30. Laboratory Investigation of Measles Infection in NVRL Online HSE Public Health: Health Protection; 2024.
31. UKHSA. Measles: risk assessment for resurgence in the UK. Online 2023.
32. le Polain de Waroux O, Saliba V, Cottrell S, Young N, Perry M, Bukasa A, et al. Summer music and arts festivals as hot spots for measles transmission: experience from England and Wales, June to October 2016. Eurosurveillance. 2016;21(44):30390.
33. Arciuolo RJ, Jablonski RR, Zucker JR, Rosen JB. Effectiveness of Measles Vaccination and Immune Globulin Post-Exposure Prophylaxis in an Outbreak Setting-New York City, 2013. Clin Infect Dis. 2017;65(11):1843-7.
34. McLean HQ, Fiebelkorn AP, Temte JL, Wallace GS. Prevention of measles, rubella, congenital rubella syndrome, and mumps, 2013: summary recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 2013;62(Rr-04):1-34.
35. Strebel PM, Papania MJ, Gastañaduy PA, Goodson JL. 37 - Measles Vaccines. In: Plotkin SA, Orenstein WA, Offit PA, Edwards KM, editors. Plotkin's Vaccines (Seventh Edition): Elsevier; 2018. p. 579-618.e21.

36. Watson JC, Hadler SC, Dykewicz CA, Reef S, Phillips L. Measles, mumps, and rubella--vaccine use and strategies for elimination of measles, rubella, and congenital rubella syndrome and control of mumps: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 1998;47(Rr-8):1-57.
37. NIAC Immunisation Guidelines. Chapter 2. General Immunisation Procedures Online Royal College of Physicians of Ireland. National Immunisation Advisory Committee (NIAC); 2024.
38. Johnson H, Hillary IB, McQuoid G, Gilmer BA. MMR vaccination, measles epidemiology and sero-surveillance in the Republic of Ireland. Vaccine. 1995;13(6):533-7.
39. Vyse AJ, Gay NJ, Hesketh LM, Pebody R, Morgan-Capner P, Miller E. Interpreting serological surveys using mixture models: the seroepidemiology of measles, mumps and rubella in England and Wales at the beginning of the 21st century. Epidemiology and Infection. 2006;134(6):1303-12.
40. Leuridan E, Hens N, Hutse V, Ieven M, Aerts M, Van Damme P. Early waning of maternal measles antibodies in era of measles elimination: longitudinal study. BMJ. 2010;340:c1626.
41. Waaijenborg S, Hahné SJM, Mollema L, Smits GP, Berbers GAM, van der Klis FRM, et al. Waning of Maternal Antibodies Against Measles, Mumps, Rubella, and Varicella in Communities With Contrasting Vaccination Coverage. The Journal of Infectious Diseases. 2013;208(1):10-6.
42. Klinge J, Lugauer S, Korn K, Heininger U, Stehr K. Comparison of immunogenicity and reactogenicity of a measles, mumps and rubella (MMR) vaccine in German children vaccinated at 9–11, 12–14 or 15–17 months of age☆☆Results of this study were presented at the annual meetings of the German Society for Paediatrics and Adolescent Medicine, September 1997, Vienna (Austria) and the German Society for Paediatric Infectious Diseases, November 1997, Berlin (Germany). Vaccine. 2000;18(27):3134-40.