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TECHNICAL REPORT

Public health considerations for mpox in EU/EEA countries

April 2023

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All experts have submitted declarations of interest, and a review of these declarations did not reveal any conflict of interest.

Suggested citation: European Centre for Disease Prevention and Control. Public health considerations for mpox in EU/EEA countries. Stockholm: ECDC; 2023.

Stockholm, April 2023

ISBN 978-92-9498-629-0
doi: 10.2900/79332
Catalogue number TQ-05-23-129-EN-N

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Abbreviations

EU/EEA	European Union/European Economic Area
EMA	European Medicines Agency
FFP	Filtering Face Piece
GBMSM	Gay, bisexual and other men who have sex with men
MPXV	Monkeypox virus
MS	Member States
MSM	Men who have sex with men
MVA-BN	Modified Vaccinia Ankara – Bavarian Nordic
PEPV	Post-exposure vaccination
PPV	Pre-exposure vaccination
RCCE	Risk Communication and Community Engagement
STIs	Sexually Transmitted Infections

Executive summary

Since 16 May 2022, and as of 4 April 2023, 21 170 cases of mpox (formerly known as monkeypox) have been reported by countries within the European Union/European Economic Area (EU/EEA).

Early diagnosis, isolation, partner notification, and contact tracing, supported by appropriate vaccination strategies and behaviour change in case of increased transmission, remain key for the effective control of this outbreak. From the beginning of the current multi-country outbreak, vaccination has been considered as an additional measure to complement primary public health interventions. Mass vaccination against mpox was not required nor recommended and such approach remains valid today. Mpox vaccines can be used as post-exposure vaccination (PEPV) or as primary preventive (pre-exposure) vaccination (PPV). Vaccination programmes must be backed by thorough surveillance and contact tracing and accompanied by a strong information campaign and robust pharmacovigilance.

The number of countries rolling out mpox vaccination campaigns has increased since the beginning of the outbreak. Based on the data reported in relation to the administration of vaccine doses, the vaccine strategies adopted focused on PPV, targeting males aged between 25 and 59 years, and subcutaneous administration. Between September 2022 and February 2023, a total of 336 976 vaccine doses were administered in 25 EU/EEA countries. PEPV was implemented in the early months of the outbreak, but it was quickly followed by PPV, with the majority of doses (86%) administered as PPV for the overall period. An observed increasing trend in the proportion of 'second doses' of the total number of doses administered monthly reported over time suggests that countries are completing the standard primary vaccination schedule (two doses), while the proportion of 'first doses' (new vaccinees) is decreasing.

While some encouraging preliminary evidence is emerging on the performance of the MVA-BN vaccine, more robust data on vaccine efficacy and effectiveness are needed. It is important that if targeted national vaccination programmes are considered, they should be optimally implemented within a framework of collaborative research and clinical trial protocols with standardised data collection tools. Health promotion interventions and community engagement are also critical to ensure effective outreach and high vaccine acceptance and uptake among those most at risk of exposure.

Risk communication and community engagement are also essential to achieving results across all the proposed measures: testing, partner notification or contact tracing, isolation of cases, vaccination, and behaviour change. Close collaboration with civil society and community-based organisations serving populations at risk is key for the success of risk communication and community engagement efforts. This also includes liaising with venue owners and organisers of Pride events. Testing should be made available to improve rapid access, particularly in clinical settings that serve gay, bisexual or other men or transgender people who have sex with men, as this is where the populations at highest risk are likely to access care. There is a need to raise awareness among clinicians that new cases of mpox may arise in the spring and summer. Clinicians should be made aware of how to rapidly detect and report cases of mpox to public health authorities to enable timely and responsive public health interventions.

Background

Mpox (formerly known as monkeypox) is a zoonotic disease caused by the monkeypox virus (MPXV) [1,2]. The disease is endemic in some regions of Central and West Africa; outbreaks outside of the African continent have also occurred. The first outbreak of mpox reported outside of Africa was linked to the importation of infected mammals in 2003 into the United States [3,4]. In 2022, multiple cases of mpox with no epidemiological link to travel or imported mammals were identified for the first time in non-endemic countries worldwide, including European Union/European Economic Area (EU/EEA) countries. These mpox cases have been identified primarily, but not exclusively, among men who have sex with men (MSM). In addition, cases showed a somewhat different clinical presentation of symptoms compared with those previously reported in endemic areas [5-7]. The attributing factors for this outbreak are not yet fully understood, in particular whether the increase in cases was linked to seasonal mass-gathering events.

Please refer to ECDC's factsheet for further information on mpox [8].

Aim

The aim of this document is to provide advice and considerations, based on currently available evidence, to public health authorities in EU/EEA countries on how to prepare for and respond to mpox cases should an increase occur in the coming months.

Target audience

Public health authorities at national, regional, or local level in EU/EEA countries.

Epidemiological update

Since late April 2022, and as of 4 April 2023, 21 170 cases of mpox have been reported from 29 EU/EEA countries, including six deaths. Most cases have been detected in males (98.1%) aged between 18 and 40 years (64.6%), and primarily among MSM. From the total number of cases reported, 1.2% (262) have required hospitalisation for clinical care and eight cases were admitted to intensive care units. Among those with information related to HIV status (10 442), 38.3% were HIV-positive.

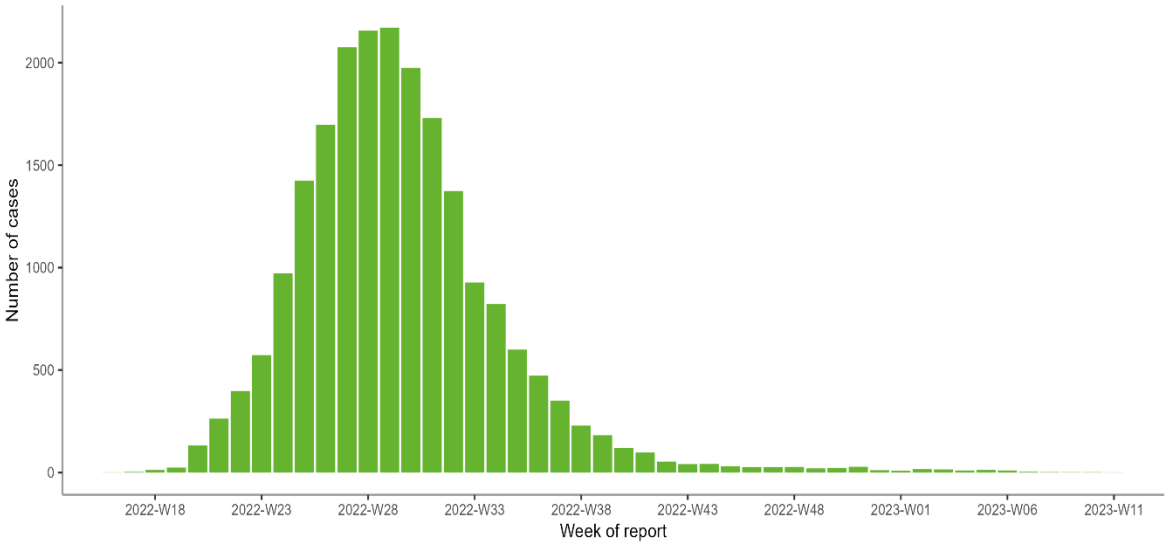
As of 4 April 2023, 1.8% and 0.4% of the total number of cases have been reported in women and children (0–17 years), respectively, with no change observed over time. Infections through occupational exposure were rare, with two infections among healthcare workers with occupational exposure and one case with laboratory exposure were also reported to The European Surveillance System (TESSy). Moreover, two additional cases of occupational exposure (healthcare workers) have been reported in the literature [9].

The epidemiological curve of all mpox cases reported in the EU/EEA shows that the weekly number of mpox cases reported in the EU/EEA peaked in July 2022 and a steady declining trend has been observed since, reaching a plateau with very low numbers since the end of December 2022 (Figure 1).

According to WHO, as of 3 April 2023, 86 913 confirmed mpox cases had been reported globally, of which 24.4% were from EU/EEA countries [10]. Globally, the mpox outbreak has also showed a decreasing trend. The region of the Americas is currently reporting the highest number of cases among all WHO regions [10].

A detailed summary and analysis of case-based data reported through TESSy since 2 June 2022 by all the countries and areas of the WHO European Region, including the 27 countries of the EU, Western Balkans countries, and an additional three countries of the EEA, can be found in the Joint ECDC-WHO Regional Office for Europe Surveillance Bulletin [11].

Figure 1. Number of confirmed mpox cases reported weekly in the EU/EEA, from 22 April 2022 to 4 April 2023



Vaccination

Vaccine effectiveness and vaccination strategies

Authorised vaccine against MPXV and considerations for use

Since 22 July 2022, the third-generation non-replicating smallpox vaccine Imvanex™ (Live Modified Vaccinia Virus Ankara – Bavarian Nordic or MVA-BN) has been authorised by the European Medicines Agency (EMA) for protection against mpox in adults [12,13]. The vaccine had been approved for active immunisation against smallpox in 2013. A summary of the evidence informing this section is included in Annex 1.

In the EU/EEA, Imvanex is authorised to protect adults from mpox as well as disease caused by vaccinia virus. These new indications were added to Imvanex's existing authorisation against smallpox, which has been in place in the EU/EEA since 2013. For protection against mpox, Imvanex is to be administered as a subcutaneous injection (0.5 ml), with a two-dose regimen, with the second dose given at least 28 days after the first as primary vaccination to individuals previously not vaccinated against smallpox, monkeypox or vaccinia viruses [14]. At time of authorisation, data from human and animal studies suggested that a single dose of MVA-BN may offer fast protection against mpox, and that the second dose mainly serves to extend the durability of protection [12]. Similarly, it was indicated that a single booster vaccination dose (0.5 ml) may be considered for individuals previously vaccinated against smallpox, monkeypox, or vaccinia viruses, although there are inadequate data to determine the appropriate timing of the booster doses [14]. The safety profile of MVA-BN is favourable, with mild to moderate side effects. Older generation smallpox vaccines have significant side effects and are not authorised by EMA.

MVA-BN is authorised for use against infection and disease caused by both smallpox and MPXV in the United States (Jynneos™) and Canada (Imvamune™) as well as other related orthopoxviruses (Canada only).

Considering the limited supplies of Imvanex in the EU/EEA in summer 2022, in August 2022 EMA's Emergency Task Force issued a recommendation to support vaccination strategies for antigen sparing (intradermal delivery of a fractional dose) [15]. The evidence reviewed at that time indicated that the lower intradermal dose of the vaccine (one fifth of the subcutaneous dose) has a comparable humoral immunogenicity to the standard subcutaneous dose.

Review of evidence of performance of MVA-BN vaccine against mpox

Robust data on the clinical efficacy of the third-generation vaccines against mpox are still lacking, but the first results of vaccine effectiveness studies are becoming available. The evidence available indicates that the MVA-BN vaccine provides protection against mpox. Infection can still develop after one vaccine dose, but illness appears less clinically severe and hospitalisations are reduced.

In the US, the performance of the rollout of vaccination campaigns against mpox is being assessed by monitoring rates of mpox cases by vaccination status [16,17]. Data analysis across 43 US jurisdictions showed that mpox incidence among males aged 18–49 years eligible for MVA-BN vaccination was 9.6 times higher among unvaccinated males compared with those who had received two vaccine doses, and 7.4 times higher compared to those who had received only the first dose. Preliminary evidence indicated no difference in protection between subcutaneous and intradermal administration routes. Rates were not adjusted for age, underlying medical conditions (such as HIV status), or other factors (risk behaviours). In addition, data from Illinois identified 90 MPXV infections among 7 339 individuals (1.2%) who had received their first dose of MVA-BN. Thirty-seven and 32 cases occurred one to seven and eight to 14 days after vaccination, respectively, comprising 77% (69/90) of all post-vaccination cases. The median time between vaccination and infection was 8.5 days (IQR, 4–13; range, 1–58 days). Some of the limitations of the study include the single site, the small number of patients and the lack of uniformity in the post-vaccination observation period. In addition, the majority of post-vaccination mpox infections occurred within two weeks after the first dose of the vaccine, before full effectiveness was likely to have been achieved, based on immunogenicity data [18]. An analysis comparing probable and confirmed MPXV infections among unvaccinated people and those who had received one Jynneos vaccine dose ≥14 days before illness onset found that the odds of fever, headache, malaise, myalgia, and chills were significantly lower among vaccinated patients than among unvaccinated patients indicating that one dose might attenuate the severity of illness and reduce hospitalisation in individuals who become infected after vaccination [19,20]. Unpublished data from a matched case-control study in 18-49-year-old males showed that the Jynneos vaccine is effective at reducing the risk of mpox, with two doses providing the best protection regardless of how the vaccine was administered (adjusted VE= 69% (95% CI=48–81%)) [21].

In the UK, a study showed a vaccine effectiveness of 78% (95% CI=54–89%) after a single dose of MVA-BN vaccine among high-risk gay, bisexual and other men who have sex with men (GBMSM) of all age-groups. The study used the case-coverage method, which involves comparing vaccine coverage in cases to vaccine coverage in the eligible population [22].

In France, a single-centre observational study identified 12 (4%) confirmed cases of MPXV infection among 276 individuals vaccinated with one dose of MVA-BN after exposure with a confirmed case of mpox, none of the 12 cases experienced severe clinical disease. Other limitations of the study included open label design, the fact that exposure to mpox was not assessed and the lack of a control group [9]. An additional observational study identified 11 (10%) confirmed MPXV cases among 108 adults who received one dose of MVA-BN after exposure to mpox [23]. The clinical course among those affected was mild and none were hospitalised. In addressing the seemingly high proportion of breakthrough mpox the authors emphasise the fact that PEPV aims not only to prevent symptomatic disease but also to improve the course of illness and to prevent further viral transmission. In addition, protection after a single MVA-BN dose could be considered incomplete and also the effectiveness of PEPV is dependent on the time interval between exposure and vaccine administration (ideally within four days).

In Israel, an observational, retrospective population-based cohort study used data obtained from electronic medical records (52% of the Israeli population) to evaluate the vaccine effectiveness after providing one vaccine dose. Among 2 054 male individuals that met vaccine eligibility criteria, 1 037 (50%) were vaccinated and completed at least 90 days of follow-up. During the study period, five and 16 infections were confirmed in vaccinated and unvaccinated individuals, respectively and the adjusted vaccine effectiveness was estimated at 86% (95% CI: 59%–95%) [24]. Among 1 970 GBMSM aged 18–42 years the vaccine effectiveness was 79% (95% CI: 24%– 94%). Results suggest that a single dose of MVA is associated with a significantly lower risk for MPXV infection in high-risk individuals [25]. Lipsitch et al. estimated the magnitude of confounding by calendar time in the analysis published by Wolff Sagy et al. and argued that the true vaccine effectiveness was likely considerably lower than the adjusted effectiveness of 86% that was reported, although it is impossible from the summary data published to estimate the fully adjusted vaccine effectiveness [24,26].

Detailed information on vaccine effectiveness studies can be found in Table A5.

Vaccination strategies

From the beginning of the current multi-country outbreak vaccination has been considered as an additional measure to complement primary public health interventions [27-30]. Mass vaccination against mpox was not required nor recommended and this approach remains valid today.

Mpox vaccines can be used as post-exposure vaccination (PEPV) or as primary preventive (pre-exposure) vaccination (PPV). The two different approaches are summarised as follows:

Primary preventive (pre-exposure) vaccination (PPV)

PPV refers to the vaccination of groups of individuals at high risk of exposure to MPXV infection. The level of risk of infection may differ between these groups, is linked to the specific epidemiological situation, and both aspects could be used by the countries for prioritisation purposes in case of limited vaccine supply.

As relevant for the epidemiological context, countries should consider prioritising PPV among individuals at substantially higher risk of exposure to MPXV, such as individuals identifying themselves as gay, bisexual, or other men or transgender people who have sex with men according to a risk assessment based on certain epidemiological or behavioural criteria (e.g. recent history of multiple sexual partners or plans to engage with multiple partners, attending sex on premises venues, or group sex or chemsex practices, use of or eligibility for pre-exposure prophylaxis for HIV, recent history of bacterial sexually transmitted infections, etc). In addition, PPV could be considered for workers in sex-on-premises venues, if they are regularly exposed to items (i.e. linens) or surfaces likely to be contaminated with body fluids or skin cells, and other groups at higher risk, such as sex workers. PPV for others who believe they are also at risk, or who do not wish to declare which risk group they belong to, could be considered based on a case-by-case assessment. PPV for occupational exposure of health workers, especially those at repeated risk of exposure, laboratory personnel (e.g. laboratory staff working with orthopoxviruses or in clinical laboratories performing diagnostic testing for MPXV), and outbreak response staff could also be considered based on risk assessment.

PPV should not be considered solely on the basis of higher risk of severe disease (e.g. children, pregnant women, and immunosuppressed individuals are considered as having a higher risk of severe disease) [12,30].

To ensure effective outreach, high vaccine acceptance and uptake among those most at risk of exposure, targeted health promotion interventions and community engagement is deemed necessary.

Post-exposure preventive vaccination (PEPV)

PEPV refers to the immunisation against MPXV of close contacts of cases to prevent the onset of disease or mitigate disease severity. Such strategy depends on the possibility to identify contacts of cases through contact tracing.

The priority target groups for PEPV are close contacts of cases (i.e. sexual partners, household contacts, healthcare workers, and individuals with other prolonged physical or high-risk contact[1]). In the context of limited supply, contacts with a high risk of developing severe disease if infected, such as children, pregnant women, and immunocompromised individuals, should be prioritised for PEPV based on a case-by-case risk assessment.

PEPV should be administered within four days of first exposure (and up to 14 days after exposure in the absence of symptoms) thus community engagement efforts for early identification of contacts around cases are very important.

Overall, vaccination programmes should be backed by thorough surveillance and contact tracing and accompanied by a strong information campaign and robust pharmacovigilance.

Vaccination-related conclusions and considerations

- In the current context, vaccination has been considered as an important complementary intervention to other measures including testing, contact tracing, case isolation, risk communication, and behaviour change.
- Recent studies conducted to assess the vaccine effectiveness of MVA-BN vaccine for MPXV mainly targeted individuals with a high risk of mpox. The limited evidence available indicates that the vaccine provides protection against MPXV. Infection can still appear after one vaccine dose, but illness appears less clinically severe, and hospitalisations are reduced. The evidence indicates that two doses provide highest vaccine effectiveness and therefore vaccination with two doses should be considered for all eligible individuals (refer to Annex 1).
- Mass vaccination against mpox is currently not required nor recommended.
- Considering limitations in vaccine supplies, PEPV and PPV strategies may be combined focusing on individuals at substantially higher risk of exposure and close contacts of cases, respectively.
- Ultimately, national decisions on the best strategies and target groups suited for the local epidemiological context are undertaken by Member States. It is important that at an individual level vaccination should not replace other protective measures. People who are vaccinated should continue to avoid close contact (e.g. through sexual contact, kissing, and skin to skin contact) with people who have mpox.
- Vaccination strategies will need to be kept under review as evidence on effectiveness is accumulated and adapted to the situation in each country according to epidemiology of disease.

[1] As defined in the ECDC document on Considerations for contact tracing during the monkeypox outbreak in Europe, 2022

Surveillance

National mpox surveillance

At national level, EU/EEA countries should consider setting up their mpox event-based and indicator-based surveillance and testing capacities to be able to timely identify cases and clusters of infection, to monitor the epidemiological characteristics of infection and affected population sub-groups, and to rapidly detect changes in outbreak trends. In this regard, EU/EEA countries are also encouraged to define mpox as a nationally notifiable disease. In addition, where capacity allows, it is also recommended to leverage existing HIV and STI programmes and services to integrate mpox testing and surveillance activities.

EU/EEA level mpox surveillance

From mid-March 2023 onwards, EU/EEA level surveillance by ECDC moved from a weekly to a monthly mpox indicator-based data collection through TESSy, complemented by event-based surveillance with reporting through EpiPulse (and/or EWRS depending on the event). Any significant increases in case numbers or changes in epidemiology, such as outbreaks related to mass gathering events or other settings, re-infections among cases, rise in cases among women, children, or marginalised groups (sex workers, transgender people) should be reported *ad hoc* through event-based surveillance.

Genomic surveillance

Sequencing of MPXV can support in understanding viral evolution, transmission chains and patterns of spread. Countries are encouraged to sequence a representative sample of mpox specimens and share sequences in publicly available sequence repositories, particularly when sudden clinical and/or epidemiological changes are observed. Such changes may include, but are not limited to, increase in virulence, or change in clinical disease presentation, change in performance of laboratory diagnostics, specific settings with unusually high transmission or outbreaks/cluster with unusual signature (e.g. behaviour or age-group).

Testing

Testing for MPXV should be easily accessible to those at risk of infection. Polymerase chain reaction (PCR) on skin lesion material is the preferred laboratory test for diagnosing mpox. Clinicians should be aware of symptoms and when to offer a test. People who suspect that they are infected should be aware of the need to test and where to access testing, and results should be shared with health authorities. People who have received one or two doses of vaccine should still be tested if infection is suspected.

Given that case numbers of mpox have declined substantially since the summer 2022, there might be a need to remind clinicians – especially those who do not work directly in STI clinics or with MSM – of the need to be aware of mpox symptoms and the possibility that cases may reappear. Testing should be made available to improve rapid access, in particular in clinical settings that serve gay, bisexual or other men or transgender people who have sex with men as this is where the population at highest risk are likely to access services including sexual health clinics, HIV-PreP clinics, HIV clinics and low threshold services. Testing for mpox can also be linked to testing for other STIs. Public health authorities, community partners and others should consider raising awareness among MSM of symptoms of mpox, the need for rapid testing and up-to-date information on where to access testing.

Clinicians and laboratories should be made aware of how to rapidly report cases of mpox to public health authorities as appropriate to ensure that a potential increase in transmission is rapidly detected. This will facilitate early reporting which is particularly important at the start of a possible resurgence in order to focus public health interventions appropriately. Similarly, rapid reporting to partner notification or contact tracing services can ensure that potential contacts are notified as quickly as possible.

Cases diagnosed with mpox should also be tested for HIV and other sexually transmitted infections as cases with mpox have been shown to also have high prevalence of HIV and other STIs and people with untreated HIV are more likely to have complications of mpox [31].

Further information on diagnostics can be found in the ECDC mpox factsheet.

Contact tracing and partner notification

Contact tracing and partner notification remain important measures in the response to an mpox resurgence, and previously published guidance around these measures for mpox remains relevant [32].

Rapid identification of sexual partners and of people potentially exposed to MPXV will facilitate the prompt diagnosis of potential secondary cases and access to PEPV vaccination, as well as help identify settings, events or population groups where targeted interventions are needed.

Contact tracing during the 2022 outbreak of mpox has been challenging for public health authorities in the EU/EEA and around the world due to multiple anonymous contacts, limited resources in sexual health clinics and public health settings, and concerns around stigma. Therefore, partner notification by the case or the clinical service providers is an important element to enhance counselling, testing and/or treatment of contact people.

Contact tracing and partner notification are particularly important considering emerging evidence of pre-symptomatic transmission of MPXV [33-35].

In general, promoting collaboration between public health and experienced clinical service providers (e.g. sexual health professionals) who already have established procedures for partner notification for STIs is critical, including in situations of low caseload where contact tracing may be more successful. Clinical service providers might consider routinely asking about potential exposure to MPXV during STI clinic follow-ups.

Close collaboration with civil society and community-based organisations throughout the year, and particularly in advance of Pride or other relevant events, is recommended to build trust in and acceptance of contact tracing strategies while ensuring that such strategies and accompanying risk communication are adapted to the affected groups and minimise stigmatisation.

Infection prevention and control practices

Management of ambulatory cases

Ambulatory mpox cases should be advised to avoid close contact with others. If they experience a large number of skin lesions or have respiratory symptoms, they should self-isolate in their home or other safe place. Skin lesions have the highest concentration of live MPXV compared to other sample sites; patients should therefore ideally remain in isolation until they do not experience systemic symptoms and their skin has completely healed. Isolation is not necessary for ambulatory mpox cases experiencing a limited number of lesions in areas that can be covered by clothing, provided they are advised to cover their lesions well, to practice rigorous hand hygiene and wear a well-fitting medical mask when in close contact with others. All cases should be advised to implement further hygiene measures (e.g. avoiding sharing clothes and beds and carefully wash bed linens), abstain from sex until full recovery, and should avoid contact with very young children, pregnant women, and immunocompromised people. After recovery, cases should use a condom for a total of 12 weeks as an additional precaution [36,37].

Management of hospitalised cases

Cases with severe disease have been rare and deaths are connected to underlying immune compromise and other underlying conditions. Complications include secondary bacterial skin infection, pneumonitis, myocarditis, encephalitis, keratitis and acute kidney injury [38]. However, their occurrence reinforces the need of monitoring ambulatory cases for deterioration and offering prompt treatment with antivirals (i.e. tecovirimat) and/ or referral for hospitalisation. Antivirals can also potentially provide rapid relief from some of the mpox symptoms (e.g. proctitis symptoms). Mpox cases should be admitted to a single well-ventilated room with bathroom, if hospitalised. Placement in an airborne infection isolation room should be considered if varicella-zoster virus infection is suspected or if an aerosol-generating procedure is performed. When transported outside the room, the patient should wear a well-fitting surgical mask and their lesions should be covered. Visitors should be limited. Isolation precautions should last for the duration of the rash and until lesions have crusted and new skin has formed underneath.

Health professionals involved in the diagnosis and care of suspected or confirmed mpox cases should wear appropriate personal protective equipment (PPE) including single-use gloves and a water-resistant single-use gown, a well-fitted medical mask or respirator (FFP2 or equivalent), and eye protection [39]. The selection of medical face mask or respirator should be based on a point-of-care risk assessment considering factors such as the performance of aerosol-generating procedures, as well as the immune status and clinical condition of the patient. A limited number of occupationally acquired mpox cases have been reported globally (five cases in the WHO European Region), mostly following accidental sharp injuries while sampling lesions [11,40]. Proper use of

PPE significantly decreases the risk of exposure. Health professionals exposed to MPXV should undergo a risk assessment of their exposure to determine if PEPV is recommended to prevent severe infection and should be asked to self-monitor for 21 days following their exposure for signs or symptoms of mpox.

Waste management

Clinical waste from mpox patients is classified as category A (UN3549) under the UN classification without distinguishing between clades of the virus [41,42]. During the 2022 outbreak, some national authorities based on their respective risk assessments decided to classify waste from patients infected with the circulating clade of MPXV as regular medical waste.

Cleaning and disinfection

Orthopoxviruses persist in the environment [43-45] but are sensitive to common disinfectants [46]. Mpox patients should not share utensils and other household items with others. Frequently touched surfaces should be cleaned and disinfected regularly. Cleaners in household and work settings where mpox cases are managed (e.g. hospital, care facilities), should wear gloves and a well-fitting medical mask or FFP2 respirator. Wet cleaning and disinfection of home and workplaces is recommended, instead of sweeping, dusting or vacuuming. Laundry of bed linens and clothes of mpox cases should be washed separately from other bed linens and clothes, without shaking items. No high temperature is required if detergent is used.

After cleaning and laundry appropriate hand washing or hand hygiene with alcohol-based sanitiser should follow.

For healthcare settings cleaning staff should also wear appropriate PPE and follow cleaning and disinfection guidance for cleaning the patient's room [39]. Disposable or dedicated patient care equipment should be used. Patient care equipment should be cleaned and disinfected in accordance with manufacturers' instructions before use for other patients. Equipment or other supplies that cannot be disinfected should be discarded.

Risk communication and community engagement

Risk communication and community engagement (RCCE) strategies are a core element of any outbreak response and are essential to achieving results across all the proposed measures - testing, contact tracing, isolation of cases, vaccination and behaviour change. There is evidence from the 2022 outbreak that MSM in the United States changed their sexual risk behaviour such as reducing their number of sex partners, one-time sexual encounters, and use of dating apps and finding partners at sex venues [47]. Simulations from early in the outbreak suggested that a 40% decrease in one-time partnerships could yield a 20%–31% reduction in the percentage of MSM infected and a delay in the spread of the outbreak [48]. Another modelling study from the Netherlands found that a reduction in the number of casual partners and shorter time from infection until cases abstain from sexual activity was important for reducing the number of cases at the end of the outbreak [49], and a modelling study from the United States done recently estimated that a reduction in the number of partners was an important factor for reducing the number of cases early in the outbreak [50]. Behaviour change will still be important in situations of higher transmission given that population vaccination coverage may be inadequate and there is limited data available with regards to vaccine effectiveness over time.

In the context of the mpox outbreak, ECDC, in collaboration with WHO Regional Office for Europe and civil society organisations, has produced several documents that address RCCE and provide examples of RCCE activities for mpox carried out in EU/EEA countries [51-53]. A toolkit to support RCCE strategies, including key messages for risk reduction, has been jointly developed by ECDC and the WHO Regional Office for Europe and is available for adaptation and use by public health authorities [37,54]. Editable communications materials are also available on ECDC's website.

Who should be targeted for RCCE efforts?

In a situation of low transmission, it is appropriate to focus on groups that are most at risk for acquisition and transmission of the virus: gay, bisexual or other men or transgender people who have sex with men with multiple sexual partners. Particular effort should be made to reach people experiencing the highest risk of infection; modelling suggests that transmission among MSM with high numbers of partners might have had a particularly important role in the outbreak [55-57]. Cases of mpox have reported finding partners through mobile dating apps, attendance at locations such as saunas or large events [58].

Groups at risk include MSM who attend sex-on-premises venues, are involved in group sex, chemsex or recruit partners via apps, MSM with a recent history of bacterial sexually transmitted infections, MSM who are on PrEP and MSM engaged in sex work. HIV-positive MSM are another important group to target, as a high proportion

of cases in the 2022 outbreak were HIV-positive. People with untreated HIV are also at higher risk for severe mpox [31].

The number of individuals who practice sex with multiple partners in interconnected networks or casual one-time sexual encounters will likely increase again as behaviour will revert to pre-outbreak habits. In addition, young people who become old enough to engage in sexual activity may be at risk and more susceptible due to lack of previous exposure [48].

Special efforts may also be needed to reach MSM who belong to groups that may have limited access to prevention or healthcare services and to ensure multiple language groups are covered in communications.

In addition to targeting people at risk of infection there is also a need to reach out to healthcare providers. This includes those who work in sexual health clinics and facilities that serve the populations at highest risk, but also others such as general practitioners who may have a lower level of awareness that mpox cases may resurge, in particular as Pride and other events take place.

In general, communications on mpox could be integrated where relevant into other messaging on STIs. In situations of increased transmission, specific messaging on mpox should be intensified.

What messages should be considered?

Information and messages should be tailored to the group targeted and the information channel used – including using plain language as appropriate – and should be focussed on:

- How MPXV spreads
  - The main mode of transmission is close intimate contact with infected people, in the current outbreak mostly related to sexual activity including oral, vaginal or anal sex as well as kissing or touching. Infection spreads when there is direct contact with infected sores or lesions on the skin or anus/mouth of infected people. Infection can also spread during contact with infected secretions (saliva for example) or fomites (i.e. contaminated objects), such as sex toys, bedding, etc.
- Mpox symptoms
  - Typical skin rash – either with several lesions or only a few. The rash is most commonly seen in the genital, perianal, oropharyngeal region but many patients also have rash on the trunk, face, arms and legs;
    - When communicating specifically with clinicians, it can be included that lesions might also be present in areas not noticed by the patient, e.g. in the oral cavity or intra-anally;
  - Other common symptoms include lymphadenopathy, fever, fatigue, myalgia, headache. Around half of people get these more general symptoms first before the rash and others develop them later or not at all [5,59]. Patients may also have proctitis, which can be quite painful;
  - People are usually infectious from the start of symptoms (rash or other symptoms), but some may also be infectious up to four days before symptoms start [33-35].

What to do in case of symptoms:

- Promptly seek healthcare;
- Pause sexual activity of any kind, including kissing or touching;
- Cover the lesions to the largest extent as possible, when not in isolation;
- Take a break from attending events;
- Avoid sharing towels, toothbrushes and other items such as clothes and sex toys with other people;
- After recovery, cases should use a condom for a total of 12 weeks as an additional precaution.

- Testing:
  - Importance of getting tested if symptoms appear;
  - Where to get tested.
- Vaccination:
  - Importance of getting vaccinated;
  - Where to get vaccinated;
  - Who should be prioritised (i.e. who is more at risk): e.g. gay, bisexual, or other men or transgender people who have sex with men who are at higher risk of exposure based on epidemiological or behavioural criteria (recent history of multiple sexual partners or plans to engage with multiple partners, attending sex on premises venues, or group sex or chemsex practices, use of or eligibility for pre-exposure prophylaxis for HIV, recent history of bacterial sexually transmitted infections etc.) in line with the national vaccination recommendations;
  - Importance of timely care-seeking for people who find out they have been exposed to someone with confirmed mpox infection to see if they are eligible for possible post-exposure vaccination.

- What to do if you have been in contact with someone with confirmed mpox infection, keeping in mind that transmission may occur before symptoms appear:
  - Promptly seek healthcare for advice and possible post-exposure vaccination (depending on the national vaccination recommendations);
  - Follow guidance for contacts of cases [32], in particular:
    - practice careful hand hygiene and respiratory etiquette;
    - self-monitor for symptoms compatible with mpox;
    - abstain from sexual activities for 21 days after last exposure.
- Behaviour change (targeted and time-limited in situations of increased MPXV transmission and increasing numbers of cases):
  - Consider reducing the frequency of one-time sexual encounters and the number of sexual contacts;
  - Reduce attendance at sex-on-premises venues;
  - Minimise skin-to-skin contact at clubs or events;
  - Exchange contact information with sexual partners in case sexual health follow up will be needed;
  - Use condoms – while their protective effect for mpox remains unknown as the virus can spread via rashes on other parts of the body, condoms can also prevent the spread of other sexually transmitted infections;
  - Follow advice mentioned above regarding what actions to take in case of symptoms.
- People who are vaccinated should continue to avoid close contact (e.g. through sexual contact, kissing and skin to skin contact) with people who have mpox and seek appropriate care in case they develop symptoms.

Of note, stigma and discrimination harm response efforts and can negatively impact healthcare-seeking behaviour. It will also be important to identify and address barriers to vaccination including access and confidence [60] and use insights to adapt messaging and interventions. Uncertainties on level and duration of protection should be communicated, as well as any limits of supply.

General promotion of sexual health is also relevant. It may be beneficial to undertake efforts to assess how experienced and perceived stigma impacts healthcare-seeking behaviour, to understand if stigma may be contributing to a decrease in cases reported through decreases in seeking care and testing.

How should RCCE efforts be implemented?

Risk Communication and Community Engagement interventions may be developed and carried out by different stakeholders including public health authorities, civil society organisations, community-based organisations and other non-governmental organisations, academic institutions and event organisers. It is important that adequate resources are available for community-based organisations to participate in the response. When public health authorities are designing such interventions, it is of the utmost importance that representatives of the community, such as civil society organisations, are consulted during the development phase, including on the communication channels, the communicators and the messages most suitable for outreach to target audiences. It is essential to use trusted communicators and trusted channels to effectively reach the populations at risk. Consider that different organisations may need to be approached to reach both MSM and transgender people, as well as other potentially marginalised groups such as sex workers and ethnic minorities depending on the local context. Liaising with venue owners is also important, as is reaching out to organisers of mass gathering events, in particular Pride events.

Communication in connection with events and mass gatherings and through venues including bars and clubs but also sex-on-premises venues has been effective during the 2022 outbreak. Consider that new venues may have opened up and management may have changed of other venues since the 2022 outbreak and new relationships may have to be built in order to implement RCCE efforts [61]. Mobile apps used by MSM are good avenues for communication. With regards to mass gatherings and events, public health authorities can work with organisers to reach out to attendees beforehand to communicate about getting ready for the event through timely vaccination in line with national vaccination recommendations.

To help increase access to vaccination, public health authorities can consider working with community-based organisations to implement vaccination at venues or events where MSM gather, including marginalised groups that may not easily access health care services otherwise.

In all aspects of communication, stigma needs to be considered. The ways in which stigma manifests and in which it could be a barrier to RCCE may be different in different contexts across the EU/EEA, and close collaboration with civil society is essential. Where possible, messages around mpox could be linked to broader promotion of sexual health and STI prevention and testing.

Limitations/knowledge gaps

Considerations in this document were based on the facts known to ECDC at the time of publication. Some main examples of unknowns relevant to epidemic control include:

Long-term effectiveness data on the currently available vaccines against mpox, including in young children, pregnant women, and immunocompromised individuals are scarce. This includes data on vaccine efficacy and effectiveness of one versus two doses, dose-sparing options, the duration of protection after vaccination against mpox and immunity of individuals who have previously been vaccinated against smallpox. Furthermore, the duration of natural immunity after infection and the risk for re-infection should be further investigated.

Data on risk perception and behaviour of MSM, particularly during mass gatherings and collected from local events, including for people without symptoms or who may test negative. Relatedly, sero-epidemiological studies could help better understand the immunity landscape of individuals to inform some of the open questions.

Some people with mpox do not develop symptoms at all but it is not clear whether these cases contribute to transmission and whether there may be a role for screening as an add on to other STI screening services among high-risk groups in a situation of high transmission.

Potential donors of substances of human origin should be assessed regarding the risk of mpox transmission in accordance with previously published ECDC documents [8,29] or, in the case of vaccinated donors, in accordance with the relevant EU Directives [62,63].

Self-sampling has been used for testing for other STIs and could be considered for mpox and rectal samples and samples of skin lesions taken via self-swabbing has been shown in one study to have similar accuracy to samples taken by medical personnel [64]. However, more work is needed to validate this method and to determine if it would be a useful addition to services to increase access.

Data on the use of antivirals for post-exposure prophylaxis are lacking.

More information is needed on the potential risk of human-to-animal transmission and the potential establishment of an animal reservoir in Europe. In addition, studies are needed to assess the vulnerability of European rodent and other mammal species to MPXV.

References

1. Durski KN, McCollum AM, Nakazawa Y, Petersen BW, Reynolds MG, Briand S, et al. Emergence of monkeypox—west and central Africa, 1970–2017. Morbidity and mortality weekly report. 2018;67(10):306. Available at: https://www.cdc.gov/mmwr/volumes/67/wr/mm6710a5.htm
2. McCollum AM, Damon IK. Human monkeypox. Clinical Infectious Diseases. 2014;58(2):260-7. Available at: https://academic.oup.com/cid/article-abstract/58/2/260/335791
3. Damon IK. Status of human monkeypox: clinical disease, epidemiology and research. Vaccine. 2011;29:D54-D9. Available at: https://www.sciencedirect.com/science/article/pii/S0264410X1100524X
4. Centers for Disease Control and Prevention. 2003 United States Outbreak of Monkeypox. Atlanta: CDC; 2018. Available at: https://www.cdc.gov/poxvirus/monkeypox/outbreak.html
5. Tarín-Vicente EJ, Alemany A, Agud-Dios M, Ubals M, Suñer C, Antón A, et al. Clinical presentation and virological assessment of confirmed human monkeypox virus cases in Spain: a prospective observational cohort study. The Lancet. 2022;400(10353):661-9. Available at: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(22)01436-2/fulltext
6. Girometti N, Byrne R, Bracchi M, Heskin J, McOwan A, Tittle V, et al. Demographic and clinical characteristics of confirmed human monkeypox virus cases in individuals attending a sexual health centre in London, UK: an observational analysis. The Lancet Infectious Diseases [Preprint]. 2022. DOI: 10.1016/S1473-3099(22)00411-X. Available at: https://www.sciencedirect.com/science/article/pii/S147330992200411X
7. UK Health Security Agency (UKHSA). Investigation into monkeypox outbreak in England: technical briefing 3, 19 August 2022. London: UKHSA; 2022. Available at: https://www.gov.uk/government/publications/monkeypox-outbreak-technical-briefings/investigation-into-monkeypox-outbreak-in-england-technical-briefing-3#part-5-clinical-experience
8. European Centre for Disease Prevention and Control (ECDC). Factsheet for health professionals on monkeypox. Stockholm: ECDC; 2019. Available at: https://www.ecdc.europa.eu/en/all-topics-z/monkeypox/factsheet-health-professionals
9. Thy M, Peiffer-Smadja N, Mailhe M, Kramer L, Ferré VM, Houhou N, et al. Breakthrough Infections after Postexposure Vaccination against Mpox. New England Journal of Medicine. 2022;387(26):2477-9. Available at: https://www.nejm.org/doi/10.1056/NEJMc2211944
10. World Health Organization (WHO). 2022-23 Mpox (Monkeypox) Outbreak: Global Trends. Geneva: WHO; 2023. Available at: https://worldhealthorg.shinyapps.io/mpx_global/
11. European Centre for Disease Prevention and Control (ECDC)/World Health Organization Regional Office for Europe (WHO/Europe). Monkeypox - Joint Epidemiological overview. Stockholm and Copenhagen: ECDC and WHO/Europe; 2023. Available at: https://monkeypoxreport.ecdc.europa.eu/
12. European Medicines Agency (EMA). Imvanex - Smallpox vaccine (Live Modified Vaccinia Virus Ankara). Amsterdam: EMA; 2022. Available at: https://www.ema.europa.eu/en/medicines/human/EPAR/imvanex
13. European Medicines Agency (EMA). EMA recommends approval of Imvanex for the prevention of monkeypox disease. Amsterdam: EMA; 2022. Available at: https://www.ema.europa.eu/en/news/ema-recommends-approval-imvanex-prevention-monkeypox-disease
14. European Medicines Agency (EMA). Imvanex - EPAR - Product Information. Amsterdam: EMA; 2022. Available at: https://www.ema.europa.eu/en/documents/product-information/imvanex-epar-product-information_en.pdf
15. European Medicines Agency (EMA). Considerations on posology for the use of the vaccine Jynneos/ Imvanex (MVA-BN) against monkeypox. Amsterdam: EMA; 2022. Available at: https://www.ema.europa.eu/en/documents/other/considerations-posology-use-vaccine-jynneos/imvanex-mva-bn-against-monkeypox_en.pdf
16. Payne AB. Incidence of monkeypox among unvaccinated persons compared with persons receiving≥ 1 JYNNEOS vaccine dose—32 US jurisdictions, July 31–September 3, 2022. MMWR Morbidity and Mortality Weekly Report. 2022;71(40):1278–82. Available at: https://www.cdc.gov/mmwr/volumes/71/wr/mm7140e3.htm
17. Payne AB. Reduced Risk for Mpox After Receipt of 1 or 2 Doses of JYNNEOS Vaccine Compared with Risk Among Unvaccinated Persons—43 US Jurisdictions, July 31–October 1, 2022. MMWR Morbidity and Mortality Weekly Report. 2022;71(49):1560–4. Available at: https://www.cdc.gov/mmwr/volumes/71/wr/mm7149a5.htm
18. Hazra A, Rusie L, Hedberg T, Schneider JA. Human monkeypox virus infection in the immediate period after receiving modified vaccinia Ankara vaccine. JAMA. 2022;328(20):2064-7. Available at: https://jamanetwork.com/journals/jama/article-abstract/2797135

19. Centers for Disease Control and Prevention (CDC). Case Definitions for Use in the 2022 Mpox Response. Atlanta: CDC; 2022. Available at: https://www.cdc.gov/poxvirus/mpox/clinicians/case-definition.html#probable
20. Farrar JL, Lewis NM, Houck K, Canning M, Fothergill A, Payne AB, et al. Demographic and Clinical Characteristics of Mpox in Persons Who Had Previously Received 1 Dose of JYNNEOS Vaccine and in Unvaccinated Persons—29 US Jurisdictions, May 22–September 3, 2022. American Journal of Transplantation. 2023;23(2):298-303. Available at: https://www.cdc.gov/mmwr/volumes/71/wr/mm715152a2.htm
21. Centres for Disease Control and Prevention (CDC). Preliminary JYNNEOS Vaccine Effectiveness Estimates Against Medically Attended Mpox Disease in the U.S., August 15, 2022 – October 29, 2022. Atlanta: CDC; 2022. Available at: https://www.cdc.gov/poxvirus/monkeypox/cases-data/mpx-JYENNOS-vaccine-effectiveness.html
22. Bertran M, Andrews N, Davison C, Dugbazah B, Boateng J, Lunt R, et al. Effectiveness of one dose of MVA-BN smallpox vaccine against monkeypox in England using the case-coverage method. medRxiv [Preprint]. 2022. DOI: 10.1101/2022.12.13.22282654. Available at: https://www.medrxiv.org/content/10.1101/2022.12.13.22282654v1
23. Merad Y, Gaymard A, Cotte L, Perpoint T, Alfaiate D, Godinot M, et al. Outcomes of post-exposure vaccination by modified vaccinia Ankara to prevent mpox (formerly monkeypox): a retrospective observational study in Lyon, France, June to August 2022. Euro Surveill. 2022;27(50):2200882. Available at: https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2022.27.50.2200882
24. Sagy YW, Zucker R, Hammerman A, Markovits H, Arieh NG, Ahmad WA, et al. Real-world effectiveness of a single dose of mpox vaccine in males. Nature Medicine. 2023. Available at: https://www.nature.com/articles/s41591-023-02229-3
25. Arbel R, Sagy YW, Zucker R, Arieh NG, Markovits H, Abu-Ahmad W, et al. Effectiveness of a single-dose Modified Vaccinia Ankara in Human Monkeypox: an observational study. Research Square [Preprint]. 2022. DOI: 10.21203/rs.3.rs-1976861/v2. Available at: https://europepmc.org/article/ppr/ppr550023
26. Lipsitch M, Boyer CB. Alternative analysis of mpox vaccine effectiveness data from Israel. medRxiv [Preprint]. 2023. DOI: 10.1101/2023.02.22.23286243. Available at: https://www.medrxiv.org/content/10.1101/2023.02.22.23286243v1
27. European Centre for Disease Prevention and Control (ECDC). Monkeypox multi-country outbreak - first update. Stockholm: ECDC; 2022. Available at: https://www.ecdc.europa.eu/en/publications-data/monkeypox-multi-country-outbreak-first-update
28. European Commission (EC) - Directorate-General for Health and Food Safety (DG-SANTE). Recommendations for a common EU approach regarding vaccination policies for monkeypox outbreak response. Luxembourg: EC - DG-SANTE; 2022. Available at: https://health.ec.europa.eu/system/files/2022-10/security_vaccination%20monkeypox_recommendations_en.pdf
29. European Centre for Disease Prevention and Control (ECDC). Monkeypox multi-country outbreak - second update. Stockholm: ECDC; 2022. Available at: https://www.ecdc.europa.eu/en/publications-data/monkeypox-multi-country-outbreak-second-update
30. World Health Organization (WHO). Vaccines and immunization for monkeypox: Interim guidance, 16 November 2022. Geneva: WHO; 2022. Available at: https://www.who.int/publications/i/item/WHO-MPX-Immunization
31. Mitjà O, Alemany A, Marks M, Mora JIL, Rodríguez-Aldama JC, Silva MST, et al. Mpox in people with advanced HIV infection: a global case series. The Lancet. 2023;401(10380):P939-49. Available at: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(23)00273-8/fulltext
32. European Centre for Disease Prevention and Control (ECDC). Considerations for contact tracing during the monkeypox outbreak in Europe, 2022. Stockholm: ECDC; 2022. Available at: https://www.ecdc.europa.eu/en/publications-data/considerations-contact-tracing-during-monkeypox-outbreak-europe-2022
33. Ward T, Christie R, Paton RS, Cumming F, Overton CE. Transmission dynamics of monkeypox in the United Kingdom: contact tracing study. BMJ. 2022;379:e073153. Available at: https://www.bmj.com/content/379/bmj-2022-073153
34. Miura F, Backer JA, van Rijckevorsel G, Bavalia R, Raven S, Petrignani M, et al. Time scales of human monkeypox transmission in the Netherlands. medRxiv [Preprint]. 2022. DOI: 10.1101/2022.12.03.22283056. Available at: https://www.medrxiv.org/content/10.1101/2022.12.03.22283056v2
35. Brosius I, Van Dijck C, Coppens J, Vandenhove L, Bangwen E, Vanroye F, et al. Pre- and asymptomatic viral shedding in high-risk contacts of monkeypox cases: a prospective cohort study. medRxiv [Preprint]. 2022. DOI: 10.1101/2022.11.23.22282505. Available at: https://www.medrxiv.org/content/10.1101/2022.11.23.22282505v1

36. European Centre for Disease Prevention and Control (ECDC). Questions and answers on mpox (monkeypox). Stockholm: ECDC; 2023. Available at: https://www.ecdc.europa.eu/en/monkeypox/questions-and-answers
37. World Health Organization (WHO) Regional Office for Europe and European Centre for Disease Prevention and Control (ECDC). Monkeypox outbreak: Resource toolkit for event organisers. Copenhagen and Stockholm: WHO/Europe and ECDC; 2022. Available at: https://www.ecdc.europa.eu/en/publications-data/monkeypox-outbreak-resource-toolkit-event-organisers
38. Rodriguez-Nava G, Kadlecik P, Filardo TD, Ain DL, Cooper JD, McCormick DW, et al. Myocarditis attributable to monkeypox virus infection in 2 patients, United States, 2022. Emerging Infectious Diseases. 2022;28(12):2508-12. Available at: https://wwwnc.cdc.gov/eid/article/28/12/22-1276_article
39. European Centre for Disease Prevention and Control (ECDC). Monkeypox infection prevention and control guidance for primary and acute care settings. Stockholm: ECDC; 2022. Available at: https://www.ecdc.europa.eu/en/publications-data/monkeypox-infection-prevention-and-control-guidance-primary-and-acute-care
40. Choi Y, Jeon E-B, Kim T, Choi SJ, Moon SM, Song K-H, et al. Case Report and Literature Review of Occupational Transmission of Monkeypox Virus to Healthcare Workers, South Korea. Emerging Infectious Diseases. 2023;29(5) Available at: https://wwwnc.cdc.gov/eid/article/29/5/23-0028_article
41. World Health Organization (WHO). Guidance on regulations for the transport of infectious substances 2019 – 2020. Geneva: WHO; 2020. Available at: https://www.who.int/publications/i/item/WHO-WHE-CPI-2019.20
42. United Nations (UN). Recommendations on the transport of dangerous goods: model regulations, 21st revised edition. New York, Geneva: United Nations; 2019. Available at: http://www.unece.org/trans/danger/danger.html
43. Morgan CN, Whitehill F, Doty JB, Schulte J, Matheny A, Stringer J, et al. Environmental persistence of monkeypox virus on surfaces in household of person with travel-associated infection, Dallas, Texas, USA, 2021. Emerging Infectious Diseases. 2022;28(10):1982-9. Available at: https://stacks.cdc.gov/view/cdc/122502
44. Siedner MJ, Trinidad J, Berto CG, Brown CM, Madoff LC, Lee EH, et al. Mpox in Young Woman with No Epidemiologic Risk Factors, Massachusetts, USA. Emerging Infectious Diseases. 2023;29(4) Available at: https://wwwnc.cdc.gov/eid/article/29/4/22-1921_article
45. Nörz D, Pfefferle S, Brehm TT, Franke G, Grewe I, Knobling B, et al. Evidence of surface contamination in hospital rooms occupied by patients infected with monkeypox, Germany, June 2022. Euro Surveill. 2022;27(26):2200477. Available at: https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2022.27.26.2200477
46. Meister TL, Tao R, Brüggemann Y, Todt D, Steinmann J, Timm J, et al. Efficient Inactivation of Monkeypox Virus by World Health Organization–Recommended Hand Rub Formulations and Alcohols. Emerging Infectious Diseases. 2023;29(1) Available at: https://wwwnc.cdc.gov/eid/article/29/1/22-1429_article
47. Delaney KP. Strategies adopted by gay, bisexual, and other men who have sex with men to prevent monkeypox virus transmission—United States, August 2022. MMWR Morbidity and mortality weekly report. 2022;71(35):1126-30. Available at: https://pubmed.ncbi.nlm.nih.gov/36048582/
48. Spicknall IH, Pollock ED, Clay PA, Oster AM, Charniga K, Masters N, et al. Modeling the impact of sexual networks in the transmission of Monkeypox virus among gay, bisexual, and other men who have sex with men—United States, 2022. MMWR Morb Mortal Wkly Rep. 2022;71(35):1131-5. Available at: https://www.cdc.gov/mmwr/volumes/71/wr/mm7135e2.htm
49. Xiridou M, Miura F, Adam P, Op de Coul E, de Wit J, Wallinga J. The fading of the mpox outbreak among men who have sex with men: a mathematical modelling study. medRxiv [Preprint]. 2023. DOI: 10.1101/2023.01.31.23285294. Available at: https://www.medrxiv.org/content/10.1101/2023.01.31.23285294v2
50. Clay PA, Asher JM, Carnes N, Copen CE, Delaney KP, Payne DC, et al. Modelling the impact of vaccination and sexual behavior change on reported cases of mpox in Washington D.C. medRxiv [Preprint]. 2023. DOI: 10.1101/2023.02.10.23285772. Available at: https://www.medrxiv.org/content/10.1101/2023.02.10.23285772v1
51. European Centre for Disease Prevention and Control (ECDC). Risk communication and community engagement approaches during the monkeypox outbreak in Europe, 2022. Stockholm: ECDC; 2022. Available at: https://www.ecdc.europa.eu/en/publications-data/risk-communication-and-community-engagement-monkeypox-outbreak
52. European Centre for Disease Prevention and Control (ECDC). Interim advice on Risk Communication and Community Engagement during the monkeypox outbreak in Europe, 2022. Stockholm: ECDC; 2022. Available at: https://www.ecdc.europa.eu/en/publications-data/interim-advice-risk-communication-and-community-engagement-during-monkeypox

53. European Centre for Disease Prevention and Control (ECDC). Interim advice for public health authorities on summer events during the monkeypox outbreak in Europe, 2022. Stockholm: ECDC; 2022. Available at: https://www.ecdc.europa.eu/en/publications-data/interim-advice-public-health-authorities-summer-events-during-monkeypox-outbreak
54. World Health Organization - Regional Office for Europe (WHO/Europe) and European Centre for Disease Prevention and Control (ECDC). Catalogue of resources on mpox mass and large gathering event preparedness. Copenhagen and Stockholm: WHO/Europe and ECDC; 2023. Available at: https://www.who.int/italy/publications/m/item/catalogue-of-resources-on-mpox-mass-and-large-gathering-event-preparedness
55. Murayama H, Pearson CAB, Abbott S, Miura F, Jung S-m, Fearon E, et al. Accumulation of immunity in heavy-tailed sexual contact networks shapes monkeypox outbreak sizes. medRxiv [Preprint]. 2022. DOI: 10.1101/2022.11.14.22282286. Available at: https://www.medrxiv.org/content/10.1101/2022.11.14.22282286v1
56. UK Health Security Agency (UKHSA). Investigation into monkeypox outbreak in England: technical briefing 8. London: UKHSA; 2022. Available at: https://www.gov.uk/government/publications/monkeypox-outbreak-technical-briefings/investigation-into-monkeypox-outbreak-in-england-technical-briefing-8#part-5-transmission-dynamics
57. Endo A, Murayama H, Abbott S, Ratnayake R, Pearson CA, Edmunds WJ, et al. Heavy-tailed sexual contact networks and monkeypox epidemiology in the global outbreak, 2022. Science. 2022;378(6615):90-4. Available at: https://www.science.org/doi/full/10.1126/science.add4507
58. Iñigo Martínez J, Gil Montalbán E, Jiménez Bueno S, Martín Martínez F, Nieto Juliá A, Sánchez Díaz J, et al. Monkeypox outbreak predominantly affecting men who have sex with men, Madrid, Spain, 26 April to 16 June 2022. Euro Surveill. 2022;27(27):2200471. Available at: https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2022.27.27.2200471
59. Mitjà O, Ogoina D, Titanji BK, Galvan C, Muyembe J-J, Marks M, et al. Monkeypox. The Lancet. 2023;401(10370):60-74. Available at: https://www.sciencedirect.com/science/article/pii/S014067362202075X?via%3Dihub
60. Betsch C, Schmid P, Heinemeier D, Korn L, Holtmann C, Böhm R. Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. PLoS One. 2018;13(12):e0208601. Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0208601
61. Aidsfonds – Soa Aids Nederland. Samenwerking zorg en horeca onmisbaar in aanpak mpox-uitbraak - Cooperation between healthcare and hospitality is indispensable in tackling mpox outbreak. Amsterdam: Soaids Nederland; 2022. Available at: https://www.soaaids.nl/nl/professionals/actueel/nieuwsbericht/samenwerking-zorg-horeca-onmisbaar-in-aanpak-mpox-uitbraak
62. European Commission (EC). Commission Directive 2004/33/EC of 22 March 2004 implementing Directive 2002/98/EC of the European Parliament and of the Council as regards certain technical requirements for blood and blood components. Brussels: Official Journal of the European Union; 2004. Available at: https://www.ema.europa.eu/en/documents/regulatory-procedural-guideline/commission-directive-2004/33/ec-22-march-2004-implementing-directive-2002/98/ec-european-parliament-council-regards-certain-technical-requirements-blood-blood-components_en.pdf
63. European Commission (EC). Commission Directive 2006/17/EC of 8 February 2006 implementing Directive 2004/23/EC of the European Parliament and of the Council as regards certain technical requirements for the donation, procurement and testing of human tissues and cells. Brussels: Official Journal of the European Union; 2006. Available at: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ%3AL%3A2006%3A038%3A0040%3A0052%3AEN%3APDF
64. Ubals M, Tarín-Vicente EJ, Oller X, Mendoza A, Alemany A, Hernández-Rodríguez Á, et al. Evaluating the accuracy of self-collected swabs for the diagnosis of monkeypox. medRxiv [Preprint]. 2022. Available at: https://www.medrxiv.org/content/10.1101/2022.09.19.22280087v1
65. European Medicines Agency (EMA) and the European Centre for Disease Prevention and Control (ECDC). Vaccine Monitoring Platform. Amsterdam and Stockholm: EMA and ECDC; 2022. Available at: https://www.ecdc.europa.eu/en/about-ecdc/what-we-do/partners-and-networks/eu-institutions-and-agencies/vaccine-monitoring
66. European Network of Centres for Pharmacoepidemiology and Pharmacovigilance (ENCPP). Safety and Effectiveness of MVA-BN vaccination against MPXV infection in at-risk individuals in Germany (SEMVAc). Amsterdam: EMA; 2022. Available at: https://www.encepp.eu/encepp/viewResource.htm?id=50282
67. Cohet Catherine at the European Medicines Agency (EMA). Personal communication. Message to: European Centre for Disease Prevention and Control (ECDC). 16 March 2023.

Annex 1. Vaccination

EU-funded studies under the ECDC EMA Vaccine Monitoring Platform

As part of the ECDC EMA Vaccine Monitoring Platform activities EMA is coordinating a study on mpox in German clinics [65] which is currently being implemented. The study assesses the safety and effectiveness of MVA-BN vaccination against MPXV infection in at-risk individuals in Germany (SEMVAc) [66]. The study is a multi-centric prospective, observational cohort study with the objectives to investigate: (i) if vaccination with MVA-BN reduces the likelihood of infection with MPXV compared to non-vaccinated individuals and (ii) if pre-existing medical conditions and medication influence the risk of contracting mpox as a vaccinated person. The study is conducted among MSM who received the vaccine as pre-exposure vaccination (PPV). An observational cohort study using US large healthcare data sources (USMVAc study) among the MSM population who received either PPV or post-exposure vaccination (PEPV) will complement the SEMVAc study. The main objectives of the USMVAc study are (i) to describe mpox testing, vaccine administration patterns, including PPV or PEPV and patient characteristics and (ii) to assess the effectiveness and safety of the MVA-BN vaccine in the MSM population [67].

Vaccine supply and vaccination rollout in the EU/EEA

In September 2022, the European Commission (EC) requested that ECDC collect data on the mpox vaccines administered in the EU/EEA on a monthly basis over a period of six months (September 2022 – February 2023). ECDC collected data on mpox vaccine doses via the National Focal Points (NFPs) for Vaccine-Preventable Diseases (VPD). The vaccine data were collected by three surveys via the EU Survey tool with closing dates on 7 October 2022, 30 November 2022 and 27 January 2023, respectively. Data on vaccination target groups such as healthcare workers (HCW) or MSM were only collected in the first two surveys and then discontinued due to the limited availability of this information within the countries.

With the third survey in January 2023, the EU/EEA countries were encouraged to submit all data for 2022 since the beginning of the rollout retrospectively and were asked for additional information on the vaccine supply. This report includes all data reported to ECDC until 3 March 2023. Information collected on the vaccine doses administered included data on the total aggregate monthly number of doses administered, the aggregate monthly number of doses stratified by gender, age groups, vaccination strategy (pre- and post-exposure vaccination), application as first versus second dose, and route of administration (intradermal versus subcutaneous).

There were responses from 29/30 EU/EEA countries to any of the ECDC survey (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden).

The information presented is not exhaustive; in particular, data for January and February 2023 cannot be considered as complete. Some countries have not provided data for each month since the start of the vaccination campaign. In addition, the availability of disaggregated data (e.g. by age and sex) was limited and a few discrepancies between total and disaggregated number of doses administered were reported.

The number of countries rolling out mpox vaccination campaigns increased overtime since the beginning of the outbreak and as of 3 March 2023, 25 EU/EEA countries have provided complete or partial information on mpox doses administered.

The increasing trend in the proportion of 'second doses' of the total number of doses administered monthly reported over time suggests that countries are completing the standard primary vaccination schedule (two doses), while the proportion of 'first doses' (new vaccinees) is decreasing.

Based on the data reported in relation to administration of vaccine doses, the vaccine strategies adopted focused on PPV, male individuals aged between 25–59 years, and subcutaneous administration.

Vaccination strategies in the EU/EEA

The information on the vaccination strategies was collected from a rapid desk review of official sources (27 March to 3 February 2023), three ECC surveys (as described below), and an HSC survey (August 2022). Based on the findings of the desk review a significant number of countries (17 countries) have a strategy document published and most of them recommend PPV and PEPV vaccination as per current recommendations. This information is consistent with what has been reported during the collection of data related to vaccine doses.

Vaccination policies were available on relevant websites for the following countries: Austria, Belgium, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Norway, Portugal, Spain, and Sweden (Table A6).

Table A1. Countries with vaccination strategies (n=24)

Vaccination strategy	Countries
Primary (pre-exposure) preventive vaccination (PPV) and Post-exposure vaccination (PEPV)	Austria, Belgium, Croatia, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Latvia, Lithuania, Luxemburg, Netherlands, Norway, Portugal, Spain, Sweden
Primary (pre-exposure) preventive vaccination (PPV)	Italy, Liechtenstein
Post-exposure vaccination (PEPV)	Cyprus, Estonia, Latvia, Malta

Sources: ECDC survey responses, HSC survey responses and rapid desk review of official sources.

Vaccine rollout and vaccine doses administered in the EU/EEA

Twenty-five countries started the vaccination rollout during 2022, while vaccination has not started in four countries (Bulgaria, Greece, Lithuania, Slovakia). Table A2 shows in which month the respective countries started the vaccine rollout.

Table A2. Starting month of vaccination rollout (n=29)*, data as of 3 March 2023

Start month	Countries
May 2022	France
June 2022	Germany, Ireland, Spain
July 2022	Austria, Belgium, Iceland, Netherlands, Portugal, Sweden
August 2022	Croatia, Cyprus, Czechia, Denmark, Italy, Latvia, Luxembourg, Malta, Norway
September2022	Estonia, Finland, Slovenia
October 2022	Hungary, Poland
November 2022	--
December 2022	Liechtenstein
January 2023	--
February 2023	--
Not started	Bulgaria, Greece, Lithuania, Slovakia

As of 3 March, a total of 336 976 vaccine doses have been administered in 25 EU/EEA countries (Table A5). The three countries that have administered most of the doses are France with 148 685 doses (44%), Germany with 57 605 doses (17%) and Spain with 33 026 (10%). Across all countries, 253 403 (75%) of the doses have been administered in the months of August to October 2022.

Table A3. Number of doses administered by country by month (n=29)*, data as of 3 March 2023

Country	Year/Month									Total
	2022							2023		
	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	
Austria	---			1 150		1 286				**2 436**
Belgium	---		1 565	1 292	861	2 069	1 121	790		**7 698**
Croatia	---	---		4	121	175	72			**372**
Cyprus	---	---	10	4	2		1			**17**
Czechia	---	---				90	80	109	78	**357**
Denmark	30	104	2 804	5 072	822	289				**9 121**
Estonia	---	---	---	5	4	0	0			**9**
Finland	---	---	---	5	1 065	50	800	250		**2 170**
France	787	14 133	66 029	39 521	18 881	6 442	2 892			**148 685**
Germany	115	9 090	12 257	10 064	10 155	10 079	5 845			**57 605**
Hungary	---	---	---	---	106	183	105			**394**
Iceland	---	40	0	215	119	160	39	25		**598**
Ireland	4	28	83	363	844	1 294	2 239	2 802		**7 657**
Italy	---	---	3 808	10 356	7 473	3 090	1 082			**25 809**
Latvia	---	---		10			91			**101**
Liechtenstein	---	---	---	---	---	---	5	6	4	**15**
Luxembourg	---	---	384	684	178	55	19			**1 320**
Malta	---	---	1	1	0	0	0			**2**
Netherlands	---	785	14 292	9 638	3 101	1 408	526	39	3	**29 792**
Norway	---		8	18	94	356	494	604		**1 574**
Poland	---								261	**261**
Portugal	---	81	298	293	569	903	747			**2 891**
Slovenia	---	---	---	100	186	150	46	27		**509**
Spain			6 376	14 549	5 046	4 929	2 126			**33 026**
Sweden	---	9	50	715	1752	1411	620			**4 557**
Total	**936**	**24 270**	**107 965**	**94 059**	**51 379**	**34 419**	**18 950**	**4 652**	**346**	**336 976**

Notes: Bulgaria, Greece, Lithuania, and Slovakia have not started the mpox vaccination.
---: The vaccination campaign has not started.
**Detailed country-specific information:*
***Czechia:** Data for February 2023 are not complete.*
***Latvia**: The doses reported in December 2022 are cumulative data and include doses administered in September, October, and December 2022.*
***Poland**: The doses reported in December are cumulative data and include all doses administered since October 2022.*

All 25 EU/EEA countries provided information on doses administered by dose number; however, not all countries provided this information for each reporting month. Out of the 336 976 doses administered, 155 492 doses (46%) were administered as first dose, 90 367 doses (27%) were administered as second dose[2], and 87 881 (26%) doses were reported as unknown.

All 25 EU/EEA countries provided information on doses administered by vaccination strategy. Twelve countries reported doses administered as PPV and PEPV (Austria[3], Belgium[3], Croatia, Cyprus, Czechia, France[3], Germany[3], Ireland, Latvia, Portugal, Spain, Sweden[3]). Six countries reported data for doses administered as PPV only (Hungary, Italy, Liechtenstein, Luxembourg, the Netherlands[4], Poland), while five countries reported only doses administered as PEPV (Denmark[3], Estonia, Finland, Malta, Norway[3]). Two countries (Iceland, Slovenia) reported the strategy for the doses administered only as 'unknown' strategy. In January 2023, one country (the Netherlands) reported that the PPV vaccination campaign has been finished. Of the 256 382 doses administered with strategy information available (76% of all doses administered), 221 501 doses (86%) were administered as PPV, 10 172 doses (4%) were administered as PEPV and for 24 709 (10%) the vaccination strategy was unknown. In June and July 2022, 92% (n=852) and 13% (n=1 299) respectively, of the administered doses were

[2] The total number of doses administered as second dose in Italy includes boosters (single dose in individuals previously vaccinated for smallpox).

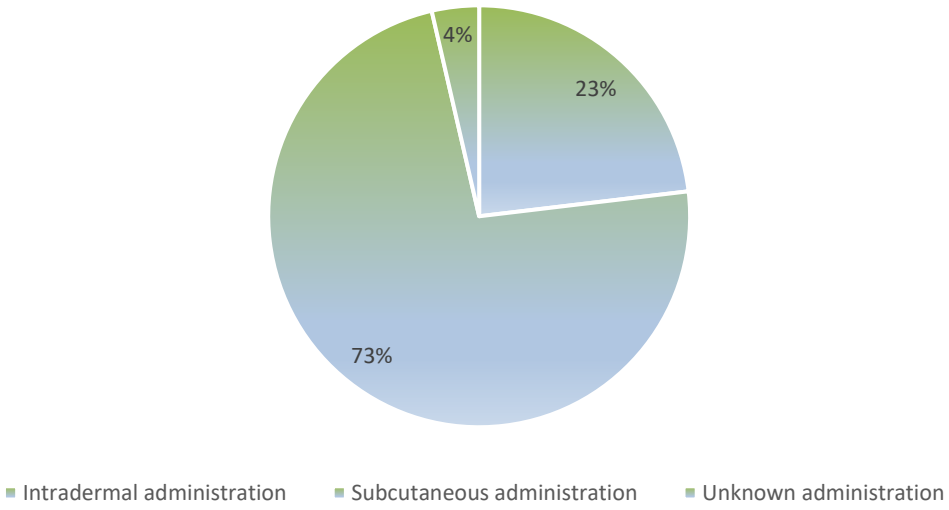
[3] This country also reported doses with unknown vaccination strategy.

[4] Data on the number of PEP vaccinations in the Netherlands are not available.

administered as PEPV; however, between August 2022-February 2023 more than 78% of the doses administered per month were administered as PPV.

Twenty-two countries reported data stratified by administration mode (Figure A1). Eleven countries reported vaccine doses administered subcutaneously only (Croatia, Cyprus, Denmark, Estonia, France[5], Hungary, Latvia, Luxembourg, Malta, the Netherlands, Slovenia), one country administered the vaccine intradermally only (Norway[6]), seven countries reported vaccine doses were administered either subcutaneously or intradermally (Belgium[6], Ireland, Italy[6], Liechtenstein, Portugal, Spain, Sweden[6] and three countries reported only doses administered with unknown application route (Austria, Czechia, Poland). One country (Germany) reported that they did not collect data on the mode of administration but assumed that all vaccinations were administered subcutaneously as this was the recommended procedure. Of the 265 679 doses administered with administration mode information available (79% of all doses administered), 194 673 doses (73%) were administered subcutaneously, 61 397 doses (23%) were administered intradermally and for 9 609 doses the administration (4%) route was unknown. In June, July and August 2022, each month at least 88% of doses were administered subcutaneously, while between September 2022 and January 2023, each month between 35% and 60% of the doses were administered intradermally. There was low completeness on the data reported on the aspect, so any interpretation of findings should be done with caution.

Figure A1. Doses administered by administration mode



Twenty-five countries provided information stratified by gender of the vaccinated individuals. Of the 249 952 doses administered with gender information available (74% of all doses administered), 187 412 doses (75%) were administered to males, 12 676 doses (5%) were administered to individuals with other gender, 3 517 doses (1%) were administered to females, and for 46 347 doses (19%) the gender of vaccinated individuals was unknown.

Data on the requested age-groups (<25 years, 25-59 years, ≥60 years) were provided by 20 countries. Of the 78 780 doses administered with information on age-group available (23% of all doses administered), 65 962 doses (84%) were administered to individuals between 25–59 years, 6 587 doses (8%) were administered to individuals ≥ 60 years and 6 231 doses (8%) were administered to individuals < 25 years of age. The majority of countries (n=17) reported that at least 75% of the doses were administered to 25–59-year-old individuals. In Cyprus (n=6) and Iceland (n=246), more than 40% of the doses were administered to individuals <25 years, while in Slovenia 37% (n=186) of the doses were administered to individuals ≥60 years.

[5] Subcutaneous administration for vaccine doses administered between June and August 2022, no information provided on administration mode for doses administered between September and December 2022.

[6] This country also reported doses with unknown administration mode.

Table A4. Further details on number of vaccines doses administered, data as of 3 March 2023

Country	Total doses	Dose number			Vaccination strategy			Administration route			Gender				Age-group (years)		
		First	Second	Unknown	PPV	PEPV	Unknown	Intra-dermal	Sub-cutaneous	Unknown	Female	Male	Other	Unknown	<25	25-59	≥ 60
Austria	2 436	238	1 043	5	800	350	4 756			4 756	209	4 547	0	0	274	4 375	107
Belgium	7 698	5 510	1 892	296	6 837	340	336	4 660	2 351	585	44	3568	13	3273	118	3579	158
Croatia	372	229	143	0	368	4	0	0	372	0	0	372	0	0	12	355	5
Cyprus	17	11	6	0	5	12	0	0	17	0	8	9	0	0	6	6	2
Czechia	357	217	157	0	363	11	0	0	0	107	9	305	0	60	11	359	4
Denmark	9 121	6 672	2 449	0	0	134	8 987	0	9 121					9121	1608	6832	714
Estonia	9	4	5	0	0	9	0	0	9	0	0	9	0	0	0	9	0
Finland	2 170	1 065	50			5						1 065					
France	148 685	25 113	36 777	86 008	61 750	1 227	5 544		80 947		1 827	60 002	363	5 544	856	7 835	619
Germany	57 605	40 593	16 668	344	51 280	4 523	1 294	0	57 605	115	459	55 767	190	1 189			
Hungary	394	217	177	0	394	0	0	0	394	0	17	377	0	0	10	374	10
Iceland	598	324	274	0			40				6	587	2	3	246	315	35
Ireland	7 657	4 750	2 907	0	7 421	236	0	6 869	739		129	7 446	4	5	402	6 888	294
Italy	25 809	13 758	11 036	1 015	25 809	0	0	22 577	3 198	34	167	23 041	72	2 529			
Latvia	101	57	44		18	83		0	101		0	101			2	93	6
Liechtenstein	15	6	9	0	15	0	0	2	13	0	0	15	0	0	0	15	0
Luxembourg	1 320	754	566	0	1 320	0	0	0	1 320	0				562			
Malta	2	1	1	0	0	2	0	0	2	0	0	2	0	0	0	2	0
Netherlands	29 792	17 758	11 824	210	29 792				29 792		96	18 496	8 318	2 882	2 327	23 368	4 096
Norway	1 574	1 081	493	0		970	604	970		604		58	845	41	34	543	27
Poland	261				261					261	123	138					
Portugal	2 891	1 977	914	0	1 977	914		2 249	642		193	2 698			208	2 603	80
Slovenia	509	261	245	3			27		509		6	503			36	287	186
Spain	33 026	32 077	949	0	31 772	1 254	0	22 766	7 442	0	211	6 844	0	20 925	24	6 864	167
Sweden	4 557	2 819	1 738	0	1 319	98	3 121	1 304	99	3 147	13	1 462	2 869	213	57	1 260	77

Table A5. Vaccine effectiveness studies

Reference	Country	Study population	Incidence/ Vaccine effectiveness
[16,17]	US (43 jurisdictions)	Males aged 18-49 years eligible for vaccination	Mpox incidence among males aged 18–49 years eligible for MVA-BN vaccination was 9.6 times as high as that among unvaccinated males compared with those who had received two vaccine doses and 7.4 times as high as that among people who had received only the first dose. Preliminary evidence indicated no difference in protection between subcutaneous and intradermal administration routes of dose 1.
[18]	U	Mpox cases	Ninety mpox infections among 7 339 individuals (1.2%) who had received their first dose of MVA-BN. Thirty-seven and 32 cases occurred one to seven and eight to 14 days after vaccination, respectively, comprising 77% (69/90) of all post-vaccination cases. The median time between vaccination and infection was 8.5 days (IQR, 4-13; range, 1-58 days).
[20]	US	Mpox cases	The odds of fever, headache, malaise, myalgia, and chills were significantly lower among vaccinated patients who received one Jynneos vaccine dose ≥14 days before illness onset than among unvaccinated patients.
[21]	US	18-49-year-old males	The vaccine was effective at reducing the risk of mpox disease, with two doses providing the best protection adjusted VE= 69%, (95% CI=48-81%) regardless of how the vaccine was administered.
[22]	UK	High-risk GBMSM of all age-groups	Vaccine effectiveness of 78% (95% CI=54-89%) after a single dose of MVA-BN vaccine.
[9]	France	Individuals who had received smallpox vaccine after high-risk exposure to mpox	Twelve (4%) confirmed cases of mpox infection among 276 individuals vaccinated with one dose of MVA-BN after exposure with a confirmed case of mpox, none of the 12 cases experienced severe clinical disease.
[23]	France	Adults who had received smallpox vaccine after high-risk exposure to mpox	Eleven (10%) confirmed mpox cases among 108 adults who received one dose of MVA-BN after exposure to mpox. The clinical course among those affected was mild and none were hospitalised.
[24,26]	Israel	Male individuals	Among 2 054 males who met vaccine eligibility criteria, 1 037 (50%) were vaccinated and completed at least 90 days of follow-up. During the study period, five and 16 infections were confirmed in vaccinated and unvaccinated individuals, respectively and the adjusted vaccine effectiveness was estimated at 86% (95% CI: 59%-95%). Lipsitch et al. estimated the magnitude of confounding by calendar time in the analysis published by Wolff Sagy et al. and argued that the true vaccine effectiveness was likely considerably lower than the adjusted effectiveness of 86% that was reported, although it is impossible from the summary data published to estimate the fully adjusted vaccine effectiveness.
[25]	Israel	GBMSM aged 18-42 years	Among 1 970 individuals, the vaccine effectiveness was 79% (95% CI: 24% to 94%). Results suggest that a single dose of MVA is associated with a significantly lower risk for MPXV infection in high-risk individuals.

Table A6. Country links for vaccination strategies

Country	Link to vaccination strategy
Austria	Source
Belgium	Source
Croatia	Source
Denmark	Source
Estonia	Source
Finland	Source
France	Source
Germany	Source
Greece	Source
Ireland	Source
Italy	Source
Luxembourg	Source
Netherlands	Source
Norway	Source
Portugal	Source
Spain	Source
Sweden	Source

ISBN 978-92-9498-629-0

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ISBN 978-92-9498-629-0