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Demographic and clinical characteristics of confirmed human monkeypox virus cases in individuals attending a sexual health centre in London, UK: an observational analysis

Nicolò Girometti, Ruth Byrne, Margherita Bracchi, Joseph Heskin, Alan McOwan, Victoria Tittle, Keerti Gedela, Christopher Scott, Sheel Patel, Jesal Gohil, Diarmuid Nugent, Tara Suchak, Molly Dickinson, Margaret Feeney, Borja Mora-Peris, Katrina Stegmann, Komal Plaha, Gary Davies, Luke S P Moore, Nabeela Mughal, David Asboe, Marta Boffito, Rachael Jones, Gary Whitlock

Summary

Background Historically, human monkeypox virus cases in the UK have been limited to imported infections from west Africa. Currently, the UK and several other countries are reporting a rapid increase in monkeypox cases among individuals attending sexual health clinics, with no apparent epidemiological links to endemic areas. We describe demographic and clinical characteristics of patients diagnosed with human monkeypox virus attending a sexual health centre.

Methods In this observational analysis, we considered patients with confirmed monkeypox virus infection via PCR detection attending open-access sexual health clinics in London, UK, between May 14 and May 25, 2022. We report hospital admissions and concurrent sexually transmitted infection (STI) proportions, and describe our local response within the first 2 weeks of the outbreak.

Findings Monkeypox virus infection was confirmed in 54 individuals, all identifying as men who have sex with men (MSM), with a median age of 41 years (IQR 34–45). 38 (70%) of 54 individuals were White, 26 (48%) were born in the UK, and 13 (24%) were living with HIV. 36 (67%) of 54 individuals reported fatigue or lethargy, 31 (57%) reported fever, and ten (18%) had no prodromal symptoms. All patients presented with skin lesions, of which 51 (94%) were anogenital. 37 (89%) of 54 individuals had skin lesions affecting more than one anatomical site and four (7%) had oropharyngeal lesions. 30 (55%) of 54 individuals had lymphadenopathy. One in four patients had a concurrent STI. Five (9%) of 54 individuals required admission to hospital, mainly due to pain or localised bacterial cellulitis requiring antibiotic intervention or analgesia. We recorded no fatal outcomes.

Interpretation Autochthonous community monkeypox virus transmission is currently observed among MSM in the UK. We found a high proportion of concomitant STIs and frequent anogenital symptoms, suggesting transmissibility through local inoculation during close skin-to-skin or mucosal contact, during sexual activity. Additional resources are required to support sexual health and other specialist services in managing this condition. A review of the case definition and better understanding of viral transmission routes are needed to shape infection control policies, education and prevention strategies, and contact tracing.

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Department of HIV/GUM, Chelsea and Westminster Hospital NHS Foundation Trust, London, UK (N Girometti MD, R Byrne MBBS, M Bracchi MD, J Heskin MBChB, A McOwan MRCP, V Tittle MBBS, K Gedela FRCP, C Scott FRCP, S Patel FRCP, J Gohil MBChB, D Nugent MBBChir, T Suchak MBChB, M Dickinson MBChB, M Feeney MSc, B Mora-Peris PhD, K Stegmann MBBS, K Plaha MBBS, G Davies MD, L S P Moore PhD, N Mughal FRCPath, D Asboe FRCP, M Boffito PhD, R Jones MBBS, G Whitlock PhD); **Imperial College Healthcare NHS Trust, London, UK** (B Mora-Peris, L S P Moore, N Mughal); **Falcon Road Clinic (Wandsworth), Central London Community Healthcare NHS Trust, London, UK** (K Stegmann, K Plaha); **Department of Infectious Diseases, Imperial College London, London, UK** (L S P Moore, N Mughal, M Boffito)

Correspondence to: Dr Nicolò Girometti, Department of HIV/GUM, Chelsea and Westminster Hospital NHS Foundation Trust, London W1D 6AQ, UK **n.girometti@nhs.net**

Introduction

Monkeypox is a zoonotic disease caused by a virus belonging to the Orthopoxvirus genus,[1] with endemic circulation reported in African regions, predominantly west and central Africa.[2] Few imported cases of monkeypox virus were reported in recent years outside Africa, including the UK,[3,4] where three of seven cases (2018–21) were related to onward transmission, including the first reported household cluster outside Africa[5] and one nosocomial transmission.[6]

After the recognition of an initial monkeypox virus case in an individual who travelled to the UK from Nigeria on May 7, 2022,[7] a cumulative total of 1285 laboratory-confirmed monkeypox virus cases had been reported by 23 countries as of June 8, 2022.[8] The size and spread of outbreak clusters across Europe are growing, and outbreak clusters have also been identified in the Americas and the Eastern Mediterrean and Western Pacific regions,[8–10] mainly in men attending sexual health centres.[9,11,12] At the time of writing, 1112 (87%) of 1285 confirmed monkeypox cases are from the WHO European region.[8] A technical briefing issued by the UK Health Security Agency (UKHSA) reported 336 laboratory-confirmed monkeypox cases in the UK as of June 8, 2022, mostly identified in men (311 [99%] of 314 cases where gender information was available) who were London residents (224 [81%] of 276 cases with a reported home address).[13]

As part of a local service evaluation, we describe the demographic and clinical features of 54 individuals with confirmed monkeypox virus infection who attended

Research in context

Evidence before this study

Historically, global evidence regarding monkeypox virus was limited to endemic circulation mainly in central and west Africa, with low numbers of sporadic, imported cases elsewhere. The recent rapid increase in monkeypox cases reported in the UK, other European countries, and the USA suggests an inter-human chain of transmission without epidemiological links to African settings. We searched PubMed from database inception to June 10, 2022, with no language restrictions, using the search terms "monkeypox" and "orthopoxvirus". Additionally, we studied materials from bulletins published by WHO, the UK Health Security Agency, and the European Centre for Disease Prevention and Control up to June 10, 2022.

Added value of this study

This study describes autochthonous monkeypox virus transmission in individuals with no link to areas of endemic transmission. We report demographics and clinical findings in cases of monkeypox found in men who have sex with men (MSM) presenting at sexual health clinics and discuss clinical differences from previous outbreaks. The current UK outbreak suggests transmission is occurring in MSM, who present with a generally mild illness and genital symptoms, suggestive of transmissibility through local inoculation during close skin-to-skin or mucosal contact during sexual activity.

Implications of all the available evidence

We report cases of confirmed monkeypox among people accessing sexual health services. Consideration of monkeypox in the differential diagnostic process is imperative for early recognition and public health control. Further studies to clarify routes of transmission and viral distribution in the population are urgently needed to update case definitions, inform infection control policies, contact tracing, prevention and education policies, and strategies to prevent ongoing viral circulation, given the high risk of further outbreaks in global settings.

open-access sexual health clinics of Chelsea and Westminster Hospital NHS Foundation Trust in London, UK, during the initial phase of the outbreak.

Methods

Study design and participants

In this retrospective, observational analysis, we reviewed the demographic and clinical characteristics of all individuals with confirmed monkeypox virus infection diagnosed between May 14 and May 25, 2022, following their initial consultation at four sexual health centres within the Department of HIV and Genitourinary Medicine of Chelsea and Westminster Hospital NHS Foundation Trust, in London, UK. We also discuss our findings compared with existing evidence. Written consent for anonymised publication of images was individually sought from participants and documented. The data collection was approved by the Chelsea and Westminster Hospital NHS Foundation Trust clinical governance committee as a service evaluation.

Procedures

Routinely collected data on clinical presentation, travel history, concomitant presence of sexually transmitted infections (STIs), and comorbidities were collected from electronic patient records (EPR) and entered into a secured, anonymised database. Information on clinical presentations at the time of patients' attendances and demographics were extracted from our internal GUMBase sexual health dashboard. Data on sexual history, including sexual practices, condom use, and number of sexual partners were also collected. For this analysis, a skin lesion was defined as a single circumscribed area and included presentations comparable to papules, pustules, fluid-filled vesicles, or eschars. We defined a rash as a skin area, demarcated or diffusely distributed, with changes in skin texture or colour and inflammatory change. Gastrointestinal symptoms were not included in the analysis as they were not routinely investigated or reported in the EPR.

Confirmed monkeypox virus cases were defined as individuals with laboratory-detected infection. All suspected cases were tested using an in-house pan-orthopoxvirus RT-PCR assay with clade-specific PCR of positive results[14] at the UK Rare and Imported Pathogens Laboratory (UKHSA; Porton Down, UK).[15] Three samples were collected from each patient with suspected monkeypox virus (an EDTA blood sample, a urine sample, and a swab taken from a suspected lesion at the clinician's discretion).

A comprehensive sexual health screen, including a fourth-generation enzyme immunoassay for HIV serology, syphilis serology (either IgM or IgG by enzyme immunoassay or rapid plasma reagin test, as appropriate), and triple-site *Chlamydia trachomatis* and *Neisseria gonorrhoeae* screening from a pharyngeal swab, a rectal swab, and a first-void urine sample with nucleic acid amplification tests, was offered to all individuals, where appropriate. Herpes virus molecular testing and *Treponema pallidum* DNA testing with PCR of suspicious lesions was also performed when deemed clinically indicated.

After our first confirmed monkeypox virus diagnosis, a new hub service in the Kobler Clinic (Chelsea and Westminster Hospital; London, UK) was set up to allow for safe monkeypox virus review and screening in line with infection control policies. Patients were informed via our website and social media that should they have symptoms meeting the UKHSA-defined monkeypox virus probable case definition,[16] they should contact a clinic to be triaged

by phone and directed for testing at the dedicated hub if deemed appropriate. At the time, patients with suspected monkeypox virus were assessed at the hub by health-care workers wearing minimum recommended personal protective equipment, including fit-tested FFP3 respirators, gowns, aprons, eye protection, and double gloves, as per infection control measures set by UKHSA[17] and reviewed by the infection control and microbiology teams at Chelsea and Westminster Hospital. The creation of the hub also allowed avoidance of mixing in communal waiting rooms.

Individuals testing positive for monkeypox virus were advised on isolation measures and regularly assessed via telephone welfare checks for patients who were not admitted to hospital. Each positive case was discussed at the High Consequences Infectious Disease (HCID) network meeting to determine the need for admission or to transfer patients to HCID units or other infectious diseases centres.

Images representing clinical presentation were collected from patients.

Role of the funding source

There was no funding source for this study.

Results

Between May 14 and May 25, 2022, monkeypox virus infection was confirmed in at least one site in 54 individuals at the four sexual health centres in our study, representing 60% and 21% of the cases reported from the current outbreak as of May 26, 2022, in the UK and worldwide, respectively.[7,8] All patients identified as men who have sex with men (MSM), and two (4%) of 54 individuals were bisexual. The median age was 41 years (IQR 34–45) and 26 (48%) of 54 individuals were born in the UK. 38 (70%) of 54 individuals were White, eight (15%) were Black or mixed race, four (7%) were Asian, and four (7%) were of other ethnicities. During the same time period, 4500 individuals attended our sexual health services, of whom 3080 (68%) identified as MSM.

52 (96%) of 54 individuals were assessed in a sexual health clinic setting at the time of testing; the remaining two were initially triaged by sexual health services and attended the local emergency department where monkeypox virus testing was done. Two individuals sought medical attention at our sexual health service after having been informed they were contacts of a confirmed monkeypox virus case and presented with associated symptoms. 52 (96%) of 54 individuals were unaware of having been in contact with a known case.

The median time between patients' reported symptom(s) onset and monkeypox virus testing was 7 days (IQR 4–11). The turnaround time from monkeypox virus testing and result availability was 2 days (IQR 1–2). The median time between reported symptom onset and the patients' last sexual contact was 2 days (IQR 0–5), with 29 (56%) of 52 individuals reporting more than five sexual partners in the 12 weeks before the monkeypox virus diagnosis; 18 (35%) of 52 individuals reported more than ten sexual partners in the 12 weeks before the monkeypox virus diagnosis. 49 (94%) of 52 individuals reported inconsistent condom use in the 3 weeks before symptom onset and 47 (90%) reported at least one new sexual partner during the same period. This information was not collected for two patients.

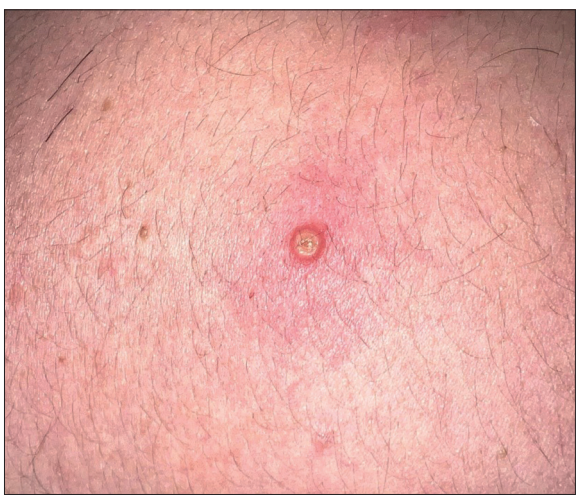

Figure 1: **Single umbilicated pustular lesion on leg**

A history of travel outside the UK within the previous 2 months was frequent (in 25 [46%] of 54 individuals), with 21 (88%) of 24 individuals who reported location of travel reporting visits to European countries (including eight to Spain, five to France, and two to the Netherlands); none reported travel to sub-Saharan Africa.

13 (24%) of 54 individuals were people living with HIV, all of whom were prescribed combination antiretroviral therapy (cART) with a CD4 cell-count greater than 500 cells per mm^3. 11 (85%) of 13 individuals with HIV had an undetectable viral load (less than 50 copies per mL) within the previous 90 days; two (15%) individuals had HIV viral loads between 200–500 copies per mL having recently commenced cART after a new HIV diagnosis. HIV pre-exposure prophylaxis use was high in the remaining cohort (39 [95%] of the 41 HIV-negative individuals).

All individuals screened for monkeypox virus were symptomatic and presented with pathognomonic skin lesions, either pustular papules with a central umbilicated dip, fluid-filled vesicles, ulcerations, or eschars; however, clinical presentation varied greatly according to the stages of monkeypox infection at the time of testing (figures 1–4). Furthermore, 44 (81%) of 54 individuals reported the presence of at least one symptom attributable to the invasive phase of the illness, such as fever, fatigue, lethargy, or myalgia at time of assessment or within the 2 weeks before the onset of skin lesions. 36 (67%) of 54 individuals reported fatigue, asthenia, or lethargy (table). In most cases, these symptoms were mild and short-lived, generally lasting fewer than 3 days. Ten individuals reported no

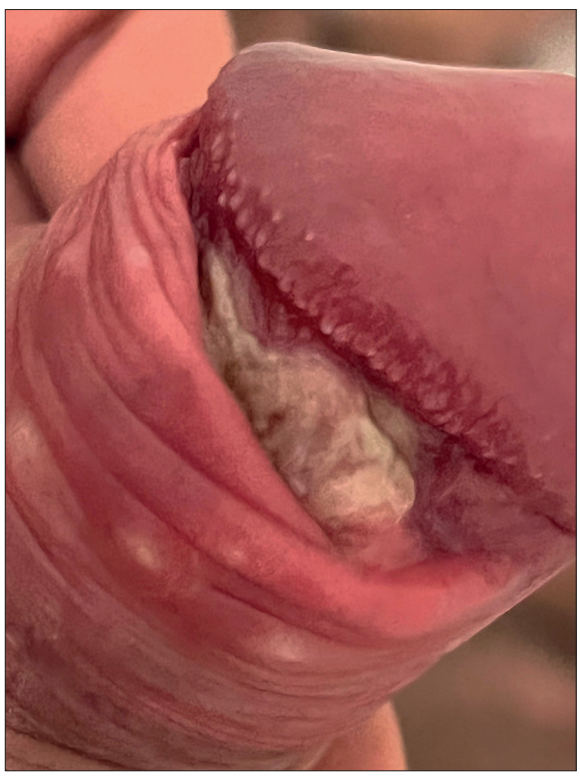

Figure 2: **Multiple coalescing lesions on penile sulcus and multiple non-coalescing lesions on penile shaft**

Figure 3: **Multiple umbilicated pustular lesions**

systemic symptoms preceding the eruptive phase of disease. Overall, 51 (94%) of 54 individuals presented with at least one skin lesion on the genital or perianal skin, and the remaining three had monkeypox virus-like lesions on extra-genital, non-perianal sites (table). 48 (89%) of 54 individuals presented with multiple skin lesions, often at various stages of evolution and with variable morphology within one clinical site. 17 (31%) of 54 individuals had visible blistering localised to one anatomical site only (seven on the perianal site and ten on penile skin), and 15 (28%) individuals presented with classic monkeypox virus skin manifestations on at least three anatomical sites, usually the genital or perianal areas, limbs, and face. The finding of skin lesions in more than three sites was seen in nine (22%) of 41 HIV-negative individuals and seven (54%) of 13 individuals living with HIV. No other relevant clinical differences were observed between these two groups.

Six individuals were found to have a clinical presentation compatible with cellulitis, complicating the initial skin appearance, mainly on the penile site. Five individuals required hospital admission; four had anogenital cellulitis and one had a disseminated presentation (with more than five body parts affected by vesicles) with facial cellulitis and severe pain. Four individuals received antibiotic treatment (two received a course of intravenous ceftriaxone and oral doxycycline, one received intravenous ceftriaxone and oral metronidazole, and one received oral doxycycline and antiviral therapy with tecovirimat) and analgesia. All individuals clinically improved and have since been discharged from hospital (median 7 days of admission, IQR 5–8).

Lymphadenopathy, mostly inguinal (either unilateral or bilateral), was described in 30 (56%) of 54 individuals, whereas only six (11%) individuals reported or presented with a skin rash. In four cases, the rash was described as erythematous, but two individuals showed a confluent maculo-papular rash, sparing the face, consistent with secondary syphilis and supported by concomitant positive syphilis serology. 14 (26%) of 54 individuals presented with chancre-like lesions compatible with primary syphilis; all were tested for *Treponema pallidum* DNA with PCR and with negative results. Herpes simplex virus PCR testing of skin lesions was done in 24 (44%) of 54 individuals, with one positive result for a concurrent herpetic infection. No testing for varicella-zoster virus was done serologically in any of the cases, but one individual was tested for varicella-zoster virus via PCR on the lesions, with a negative result. In the first 3 months of 2022, the positivity rates for chlamydial and gonococcal infections in MSM testing at our sexual health services were 10% and 15%, respectively. Sexual health screening was offered to 51 (94%) of 54 individuals being tested for monkeypox virus, and a high rate of other concurrent STIs was observed, with 13 (25%) of 51 testing positive for gonococcal or chlamydial infections (six tested positive for pharyngeal gonorrhoea, two for urethral gonorrhoea, one for rectal gonorrhoea, four for rectal chlamydia, and two for urethral chlamydia). Of these 13 individuals, two had dual gonorrhoea and chlamydia infection. STIs were detected with a higher prevalence in individuals with HIV (seven [54%] of 13 individuals) than in HIV-negative individuals (six [15%] of 41 individuals). There were no new HIV-1 diagnoses.

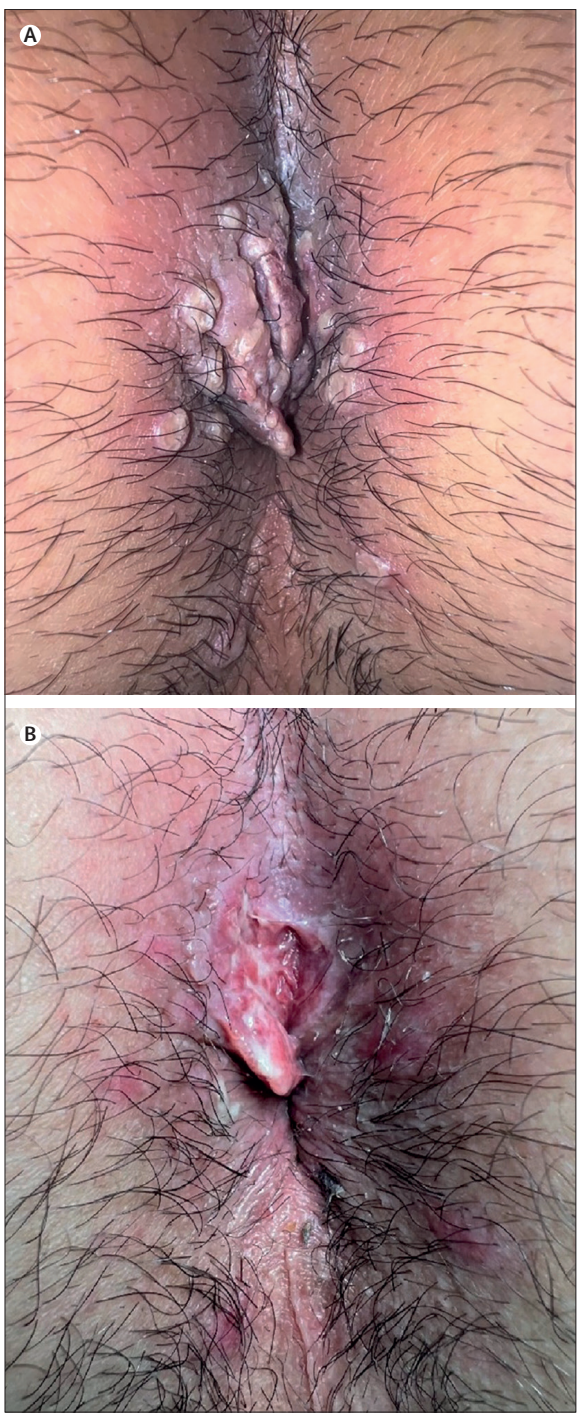

Figure 4: **Multiple ulcerative lesions on perianal skin (A) progressing into a large coalescing ulcerative lesion (B)**
Pictures taken 10 days apart.

	Patients (n=54)
Invasive phase*	
Fatigue, asthenia, or lethargy	36 (67%)
Fever	31 (57%)
Fever and fatigue, asthenia, or lethargy	23 (43%)
Myalgia	16 (30%)
Sore throat	11 (20%)
None of the above	10 (19%)
Eruptive phase	
Individuals presenting with skin lesions	54 (100%)
Multiple lesions	48 (89%)
Genital lesions	33 (61%)
Penile	31 (57%)
Scrotum	3 (6%)
Perianal lesions	24 (44%)
Lesions on limbs	27 (50%)
Arms	11 (20%)
Legs	11 (20%)
Hands	11 (20%)
Facial lesions	11 (20%)
Oropharyngeal lesions	4 (7%)†
Torso lesions	14 (26%)
Genital or perianal lesions	51 (94%)
Genital and perianal lesions	6 (11%)
Number of anatomical sites affected	
1	17 (31%)
2	22 (41%)
3	10 (19%)
≥4	5 (9%)
Lymphadenopathy	30 (56%)‡
Skin rash	6 (11%)

Data are n (%). *Patient-reported symptoms were included only when reported within 2 weeks from the onset of skin manifestations. †Two patients had lingual ulcerations. ‡All 30 patients presented with inguinal lymphadenopathy, and two also had latero-cervical lymphadenopathy.

Table: **Clinical manifestations in patients with autochtonous monkeypox viral infection**

Discussion

In this study, we report demographic data and clinical presentations of 54 confirmed cases of human monkeypox virus infection in individuals in the UK without known epidemiological links to west and central Africa, effectively describing monkeypox virus circulation in MSM presenting to sexual health clinics in London, UK.

The case burden in this outbreak has been higher than reported previously in the UK, and for the first time we have observed community transmission unlinked to travel from endemic countries, via close person-to-person contact with novel chains of transmissions (ie, sexual contact). We also provided images for the clinical presentations observed thus far, in the hope of supporting other clinicians in the diagnostic process.

Our case description highlights important differences in the clinical features previously reported in the literature. Notably, we found fatigue, asthenia, or lethargy in only 67% (95% CI 54–79) of individuals, contrasting with over 80% of cases reporting such symptoms during outbreaks in the USA and Nigeria.[18–20] Moreover, fever or febrile chills were reported in 57% (95% CI 44–71) of individuals, a

much lower finding than the 85–100% reported in outbreaks in the USA, Nigeria, and Sudan,[18,19,21,22] and more in keeping with the 47% reported in cases found in Portugal in 2022.[9] Additionally, one in five patients did not report prodromal symptoms before the eruptive phase. Lymphadenopathy was reported in 30 (56%) patients, a figure consistent with previous data from Nigeria and the USA (63% and 69%, respectively).[18,19] Pruritus has been defined as a common feature in previous reports, and although we did not routinely collect this specific information for cases not requiring hospitalisation, all patients who required hospital admission reported intense pruritus with the start of the eruptive phase.

Skin lesions have been previously described predominantly on the limbs for 81–100% of individuals with monkeypox[5,18,19] and on the face and neck in 62–97% of cases,[18,19,21] whereas only two-thirds of cases had genital involvement.[18,21] We report skin lesions being almost invariably multiple in number and morphology, with three quarters of our patients having lesions distributed in one or two anatomical sites only. Penile or perianal involvement was predominant, and a fifth of individuals presented with lesions on their face and neck.

During previously described outbreaks, the route of monkeypox virus infection has been linked to disease severity, with primary zoonotic transmission leading to invasive exposure and being associated with more severe illness and hospitalisation.[3] We have observed a generally benign illness; however, five (9%) of 54 individuals in our cohort required admission to hospital because of the evolution of genital or perianal lesions into coalescing ulcerations, often complicated by superimposed cellulitis requiring antibiotic treatment and pain requiring analgesia, underpinning the need for ongoing welfare checks after monkeypox virus diagnosis.

Our findings show a generally mild illness with lower rates of prodromal symptoms than previously described. The distribution of skin lesions seen thus far, along with high rates of concurrent STIs, imply local inoculation based on close skin-to-skin contact, probably occurring during sexual contact. However, this finding could be biased by the fact that we are sexual health providers and hence might not reflect transmission in the wider population and in vulnerable groups. Previous reports suggested potential transmissibility of monkeypox virus via sexual contact[18,21] and further clinical and biological data are needed to understand whether sexual transmissibility occurs due to close skin-to-skin contact alone or if there is a role for local inoculation from skin lesions or via bodily fluid during penetrative sex.

Given the described route of transmission of monkeypox virus infection and consequent plethora of clinical findings differing from previous descriptions, we suggest that case definitions,[16] currently detailing symptoms such as acute illness with fever (greater than 38·5°C), should be reviewed to best adapt to the current findings, as at least one in six of this cohort would have not met the probable case definition.

A fifth of our patients reported the onset of their symptoms more than 7 days before the first two confirmed monkeypox virus cases in the UK were reported by UKHSA (on May 14, 2022).[7] This finding is in keeping with latest epidemiological data showing viral circulation from around a month earlier.[13]

All the individuals in our report identified as MSM, matching the demographic reported by UKHSA, showing how 151 (99%) of 152 men interviewed were MSM.[13] Monkeypox virus human transmission in MSM has implications in terms of infection control, contact-tracing policies, education and prevention strategies, and clinical management of individuals accessing sexual health services.

Monkeypox virus is considered a high-consequence infectious disease and thus requires special measures in terms of health-care and infection control policies, including assessment of patients in personal protective equipment, avoidance of close contact, isolation, and transmission-based precautions until resolution of symptoms. All our reported cases attended for medical attention within our open-access clinics. Hence, service infrastructure required swift adaptation to comply with stringent infection control policies. Genitourinary medicine clinics will probably see patients with monkeypox virus because of the usually mild clinical presentation with genital involvement and high rates of involvement of this cohort in sexual health screening. Additional resources are urgently required to support sexual health services in managing this condition.

Limitations of this report include the retrospective nature of the data collection, which led to the inability to obtain detailed data about the length and the extent of patient exposures to possible sources of infection, and the recording of pre-diagnosis patient-reported symptoms, with no gastrointestinal symptom collection. To date, all individuals who presented to our services were symptomatic; further data on the possibility of pauci-symptomatic or asymptomatic viral transmission are warranted. Hospitalisation rates observed in our study might be an underestimate, as sexual health clinics tend to assess patients presenting with mild illnesses, whereas those with more severe presentations or who are systemically unwell might seek medical attention in emergency services, although anecdotally this has not been described. However, mortality rates observed in previous reports might be overestimated because of underreporting of mild cases, differences in health-care resources and access to timely supportive care, and a greater proportion of children included in analyses where poorer outcomes are observed. Our data are subject to selection biases, introduced by the current criteria used to offer monkeypox virus screening and testing. Current guidance and health promotion materials prompt monkeypox virus testing in symptomatic individuals who

self-define as MSM. More broadly, MSM are likely to be more knowledgeable about this condition than other population groups, in which testing is currently not being offered routinely.

Although all cases reported in this study were in MSM, it is essential to balance targeted health promotion to groups that are disproportionately affected by the current outbreak with the avoidance of intensive media coverage generating stigmatisation, and to remain alert to the possibility of spread to other groups.[23] Individuals might not perceive themselves at risk and fail to present, or indeed, might actively disengage from our services if monkeypox virus diagnosis, and the subsequent need for contact tracing and isolation, lead to inadvertent disclosure of sexual orientation or behaviour. Caution in labelling this outbreak as sexually transmitted is also needed, as it is known that monkeypox virus is transmissible by close contact, rather than uniquely in a sexual context, demanding a coordinated effort for epidemic preparedness in a situation where frequent travelling and mass gatherings represent potential barriers to the containment of this outbreak.[23]

In conclusion, our findings have important implications for monkeypox virus case recognition and definition, infection control policies, contact tracing, and future management in sexual health clinics and other broader settings. Longitudinal clinical data will help to describe the long-term sequelae, complications of infection, and outcomes in patients living with HIV or presenting with other comorbidities. Further studies are needed to confirm the modality of viral transmission occurring during this outbreak to inform infection control policies, contact tracing, and future options to tackle the spread of monkeypox virus in at-risk groups, with tools such as targeted education, health promotion, preventative or post-exposure vaccination, and antiviral therapy.

Contributors

NG did the literature search and data analysis, conceived the study, wrote the original draft of the manuscript, and created the table. RB, JH, MD, KS, KP, JG, and MF collected the data. AM, VT, CS, and TS provided resources to allow the collection of data, made intellectual contributions to the concept of the study, and reviewed the first draft. DN, BM-P, LSPM, NM, and GD wrote and edited the first draft. SP curated and edited the figures and collected the data. MBr, KG, DA, MBo, and RJ devised the methodology, conceived the study, and edited and reviewed the first draft. GW supervised the study, validated and edited the first draft, and analysed the data. RB and GW have accessed and verified all the data. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Declaration of interests

LSPM has consulted for or received speaker fees from bioMerieux, DNAelectronics, Eumedica, Dairy Crest, Pfizer, Profile Pharma, Umovis Lab, Kent Pharma, Pulmocide, Sumiovant, and Shionogi, and received research grants from the National Institute for Health Research, CW+ charity, and LifeArc. NG has consulted for or received speaker fees from Viiv Healthcare. JH has received a research grant from the CW+ charity. DA has consulted for or received speaker fees from Viiv Healthcare and Theratechnologies. BM-P has consulted for or received speaker fees from MSD. NM has consulted for or received speaker fees from Pfizer and Shionogi. MBo has consulted for or received speaker fees from Viiv Healthcare, Gilead, GlaxoSmithKline, Pfizer, Cypla, Mylan, and Janssen. MBo has also received research grants from Gilead, Viiv Healthcare, Mylan, Novavax, Janssen, Valneva, Moderna, and Roche. RJ has consulted for or received speaker fees from Viiv Healthcare and Gilead. GW has consulted for or received speaker fees from Viiv Healthcare and Gilead. All other authors declare no competing interests.

Data sharing

Individual participant data that underlie the results reported in this Article, after de-identification (text, tables, figures, and appendices), will be available to researchers who provide a methodologically sound proposal. Data will be available beginning 3 months and ending 5 years after Article publication. Proposals should be directed to n.girometti@nhs.net; to gain access, data requestors will need to sign a data access agreement.

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