Making Sense of Monkeypox & Meningococcus among MSM

Christopher Hurt, MD, FIDSA

03 August 2022

AETC AIDS Education & Training Center Program Southeast

AETC Program – National Resources

- **National Coordinating Resource Center** – serves as the central web-based repository for AETC Program training and capacity building resources; its website includes a free virtual library with training and technical assistance materials, a program director, and a calendar of trainings and other events. Learn more: https://aidsetc.org/
- **National Clinician Consultation Center** – provides free, peer-to-peer, expert advice for health professionals on HIV prevention, care, and treatment and related topics. Learn more: https://nccc.ucsf.edu
- **National HIV Curriculum** – provides ongoing, up-to-date HIV training and information for health professionals through a free, web-based curriculum; also provides free CME credits, CNE contact hours, CE contact hours, and maintenance of certification credits. Learn more: www.hiv.uw.edu

Disclosures

- This program is supported by the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services (HHS) under grant number U1OHA30535 as part of an award totaling $4.2m. The contents are those of the author(s) and do not necessarily represent the official views of, nor an endorsement, by HRSA, HHS, or the U.S. Government. For more information, please visit: https://www.hrsa.gov

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The views expressed are not necessarily those of HRSA or the NIH.

Objectives

- Describe epidemiological trends in cases of meningococcus and monkeypox in the US.
- Explain how meningococcus and monkeypox may be transmitted person-to-person.
- Recognize key clinical features of meningococcus and monkeypox.
- Discuss evidence-based approaches to prevention of these two infections, including the role of immunization.

Please be aware this presentation includes some graphic images

Man → https://shutterstock.com%2Fimage-photo%2Fyoung-surprised-man-blue-tshirt-pointing-1190324245
Eggplant → https://www.istockphoto.com/photo/rotten-eggplant-gm666576304-121513895

What do these pathogens all have in common?

Hepatitis A virus

Hepatitis B virus

Campylobacter

Salmonella

Shigella

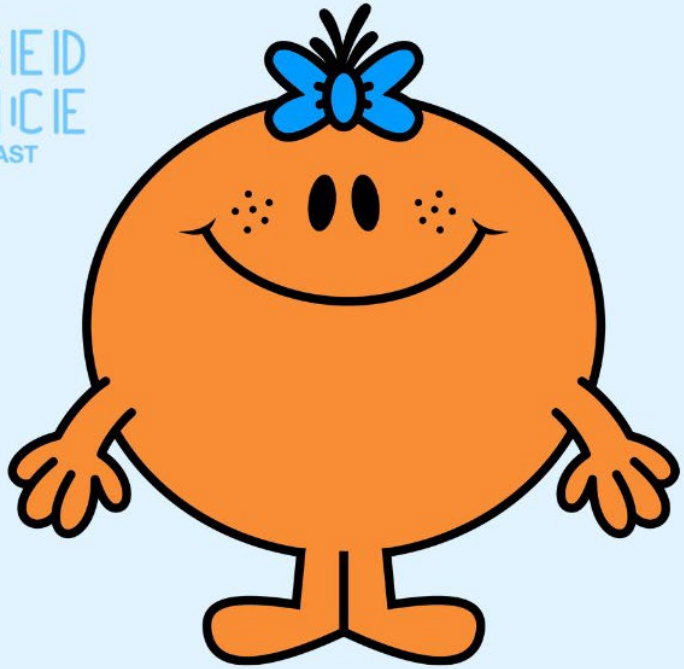
Giardia

MRSA

Monkeypox

LITTLE MISS KNOWS THAT MONKEYPOX IS NOT AN STI

THE UNBIASED SCIENCE PODCAST



IT'S SPREAD BY CLOSE PHYSICAL CONTACT WITH LESIONS.

https://mobile.twitter.com/unbiasedscipod/status/1551656243755978753

Words matter.

Choose them carefully.

AETC AIDS Education & Training Center Program Southeast

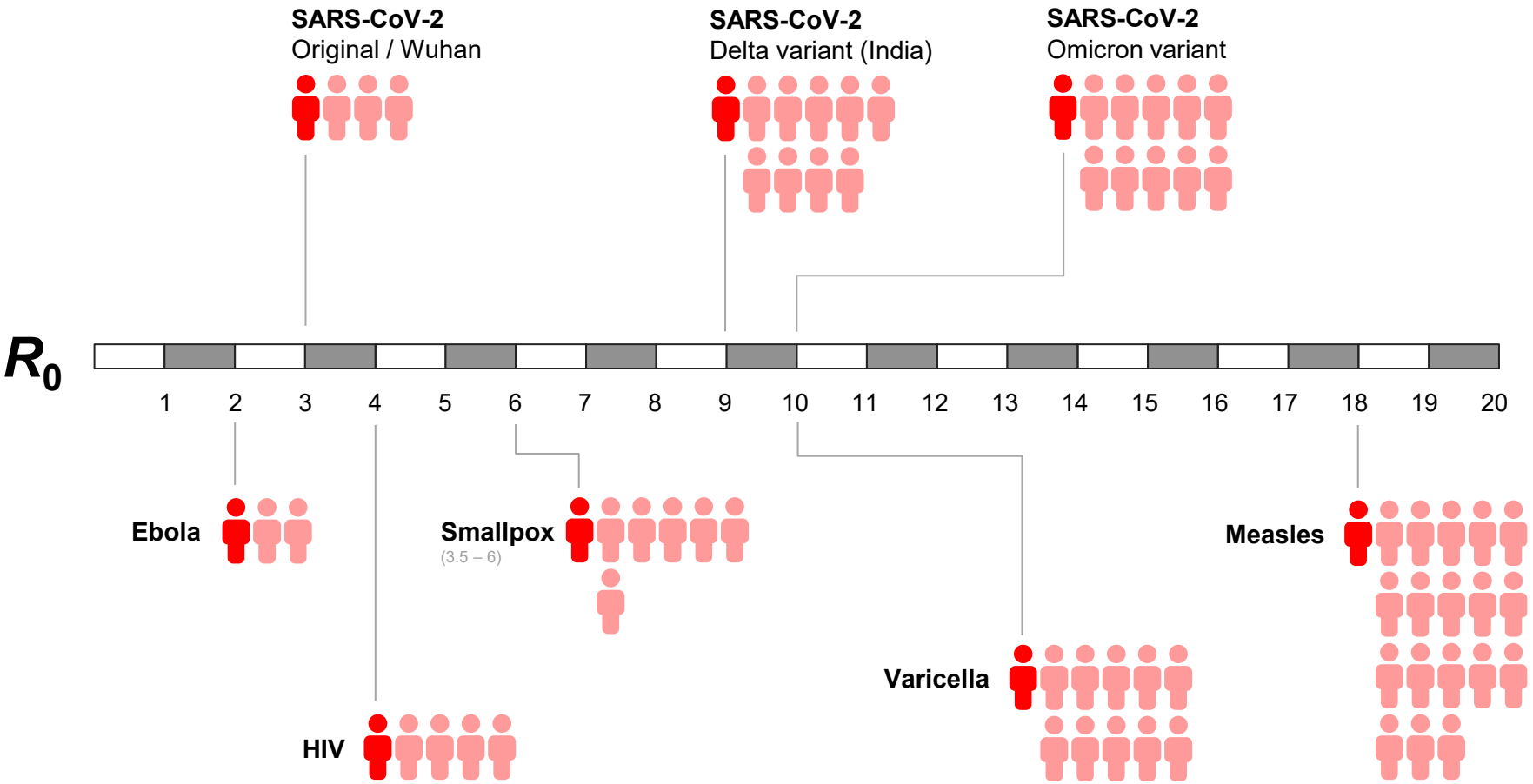
Basic reproductive number

R_0

Congo household attack rate → Nolen LD, et al. Emerg Infect Dis. 2016 Jun;22(6):1014-21. PMID: 27191380; PMCID: PMC4880088
Meningococcal household attack rates → JAMA. 1976 Jan 19;235(3):261-5. PMID: 811822 **AND** De Wals P, et al. J Infect. 1981 Mar;3(1 Suppl):53-61. PMID: 7185953

Comparing R_0 for different infections

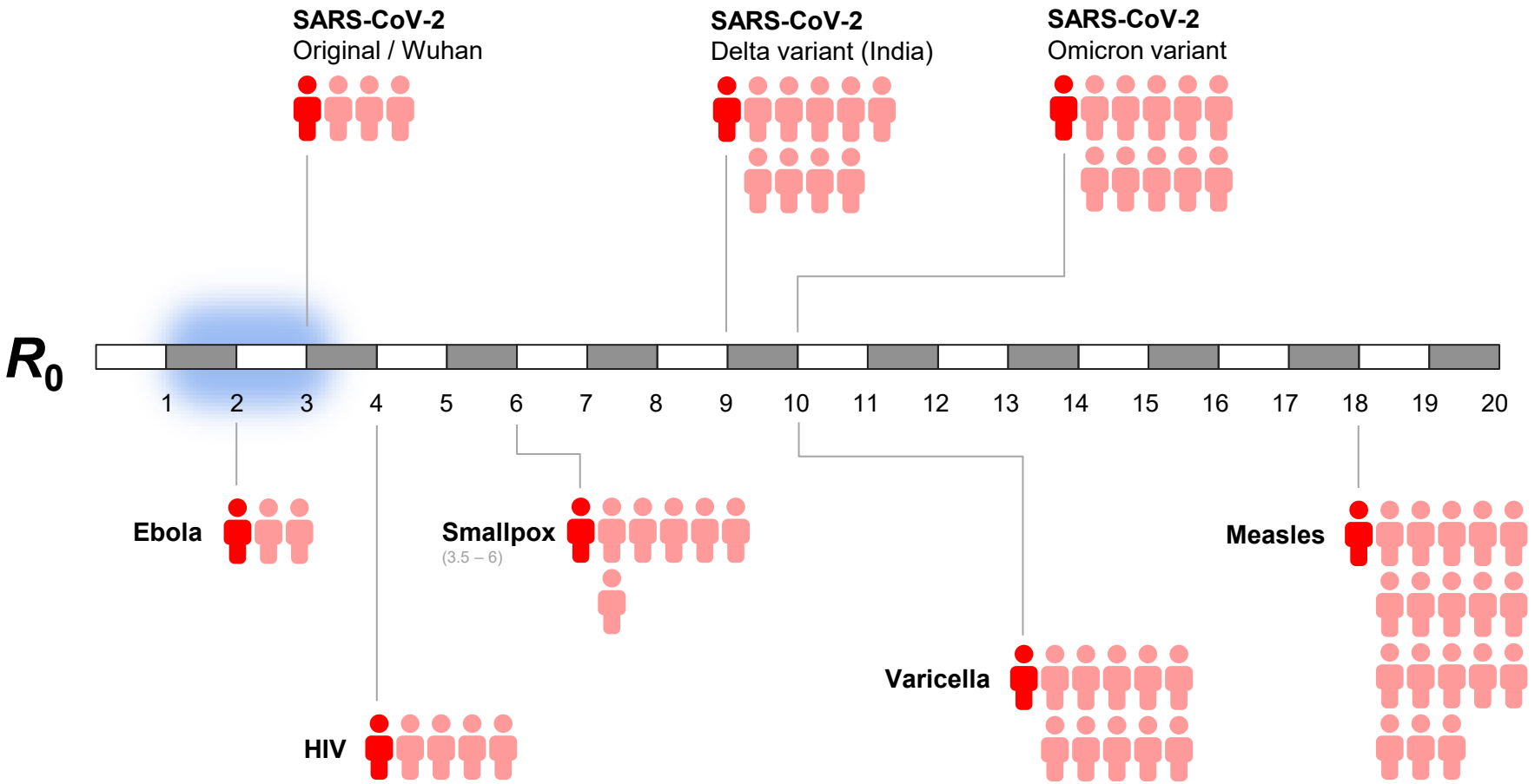
R_0 is an estimate of how many additional people will become infected after exposure to an "index" case



Based on → https://www.npr.org/sections/goatsandsoda/2021/08/11/1026190062/covid-delta-variant-transmission-cdc-chickenpox
Omicron reproductive number → https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(21)00559-2/fulltext
Smallpox in naïve population → Gani R, Leach S. Nature. 2001 Dec 13;414(6865):748-51. PMID: 11742399

R_0 for meningococcus (serogroup C) is 1.5 - 3

R_0 is an estimate of how many additional people will become infected after exposure to an "index" case



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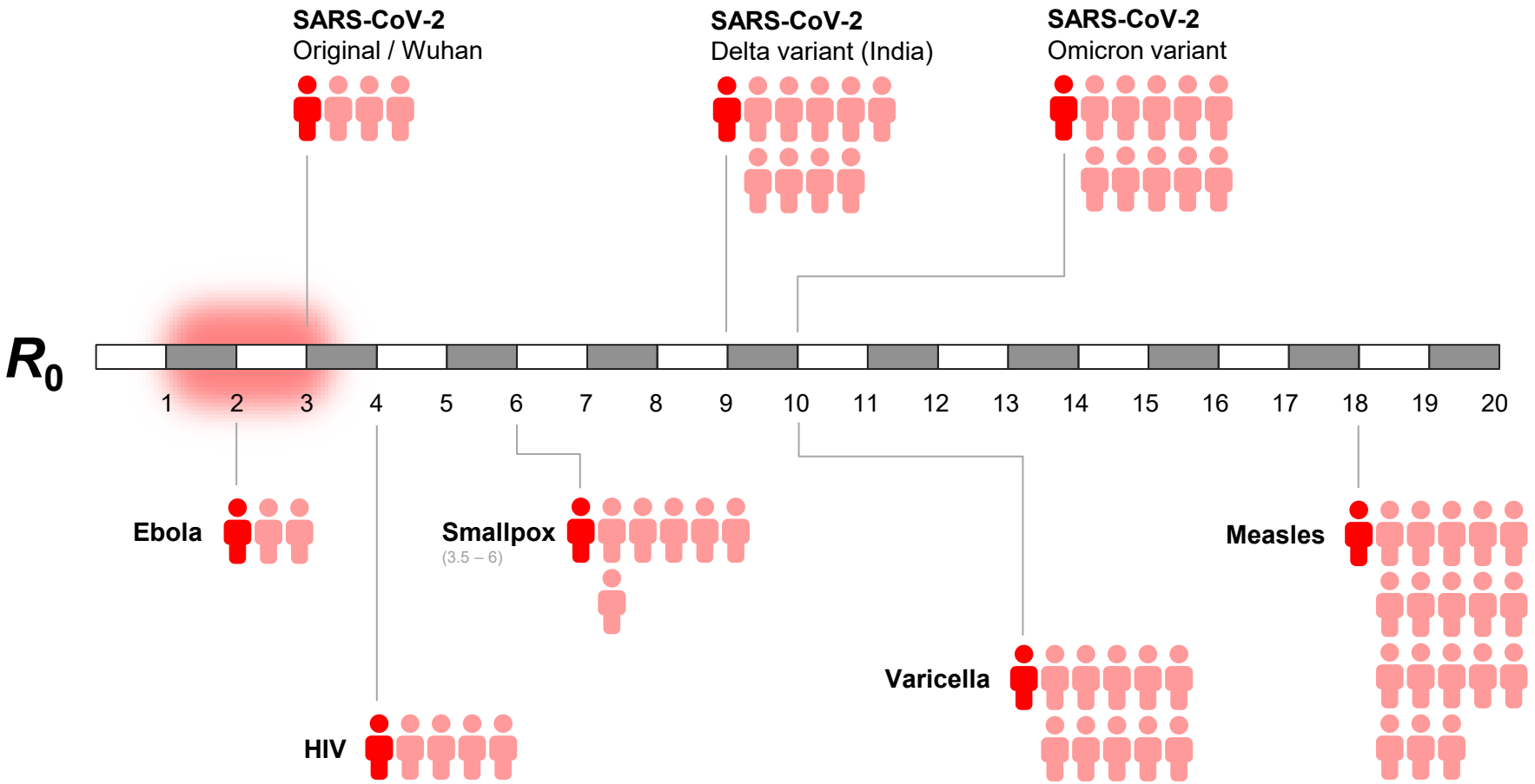
Meningococcus → Trotter CL, et al. Am J Epidemiol. 2005 Jul 1;162(1):89-100. PMID: 15961591 AND Lo Presti A, et al. Infect Genet Evol. 2020 Oct;84:104360. PMID: 32407793

R_0 for monkeypox in Congo was 1.5 to 3 (1966-1984)

R_0 is an estimate of how many additional people will become infected after exposure to an “index” case



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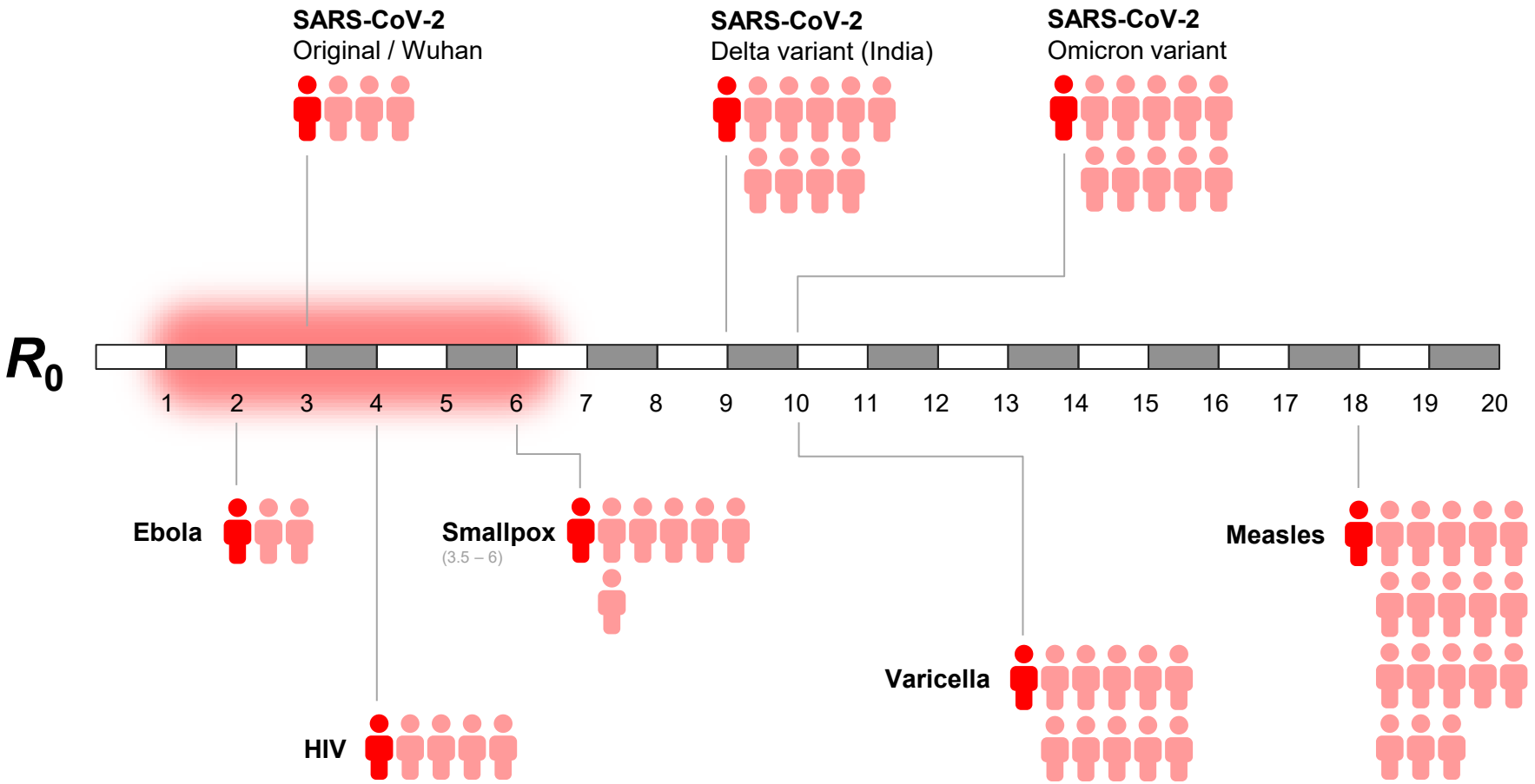
Omicron reproductive number → https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(21)00559-2/fulltext
Smallpox in naïve population → Gani R, Leach S. Nature. 2001 Dec 13;414(6865):748-51. PMID: 11742399
Monkeypox historical data → Grant R, Nguyen LL, Breban R. Bull World Health Organ. 2020 Sep 1;98(9):638-640. PMID: 33012864; PMCID: PMC7463189

R_0 for 2022 monkeypox outbreak may be 1.3 – 6

R_0 is an estimate of how many additional people will become infected after exposure to an "index" case



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Smallpox in naïve population → Gani R, Leach S. Nature. 2001 Dec 13;414(6865):748-51. PMID: 11742399
2022 monkeypox secondary case estimates → Bisanzio D, Reithinger R. Lancet Microbe. 2022 Jun 23:S2666-5247(22)00183-5. PMID: 35753315; PMCID: PMC9225111

Basic reproductive number

R_0 =

Transmissibility

probability that a given contact will result in a new infection

x

Contact rate

average rate of contact between susceptible and infected persons

x

Infectious period

how long someone with the infection can transmit it to others

Congo household attack rate → Nolen LD, et al. Emerg Infect Dis. 2016 Jun;22(6):1014-21. PMID: 27191380; PMCID: PMC4880088
Meningococcal household attack rates → JAMA. 1976 Jan 19;235(3):261-5. PMID: 811822 AND De Wals P, et al. J Infect. 1981 Mar;3(1 Suppl):53-61. PMID: 7185953

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Monkeypox	**50%** household attack rate in Congo	?	**≥ 21d** AFTER symptom onset
Meningococcus	**0.3 - 0.6%** household attack rates	?	**~10d** starting 7 days BEFORE symptom onset

VACCINE PHOTO → https://covid19.nih.gov/covid-19-topics/covid-19-vaccines

Reducing partners reduces the contact rate

"For men who have sex with men, this includes, for the moment, reducing your number of sexual partners, reconsidering sex with new partners and exchanging contact details with any new partners to enable follow-up, if needed."

– Tedros Ghebreyesus, PhD
WHO Director-General
25 July 2022

PHOTO → https://www.nature.com/articles/d41586-022-02054-7

Reducing partners also may buy time for vaccination

The Washington Post
Democracy Dies in Darkness

‘Not enough shots’: U.S. faces ‘vaccine cliff’ on monkeypox

As many as 1 million high-risk men may be unable to get two Jynneos doses for months

By Dan Diamond

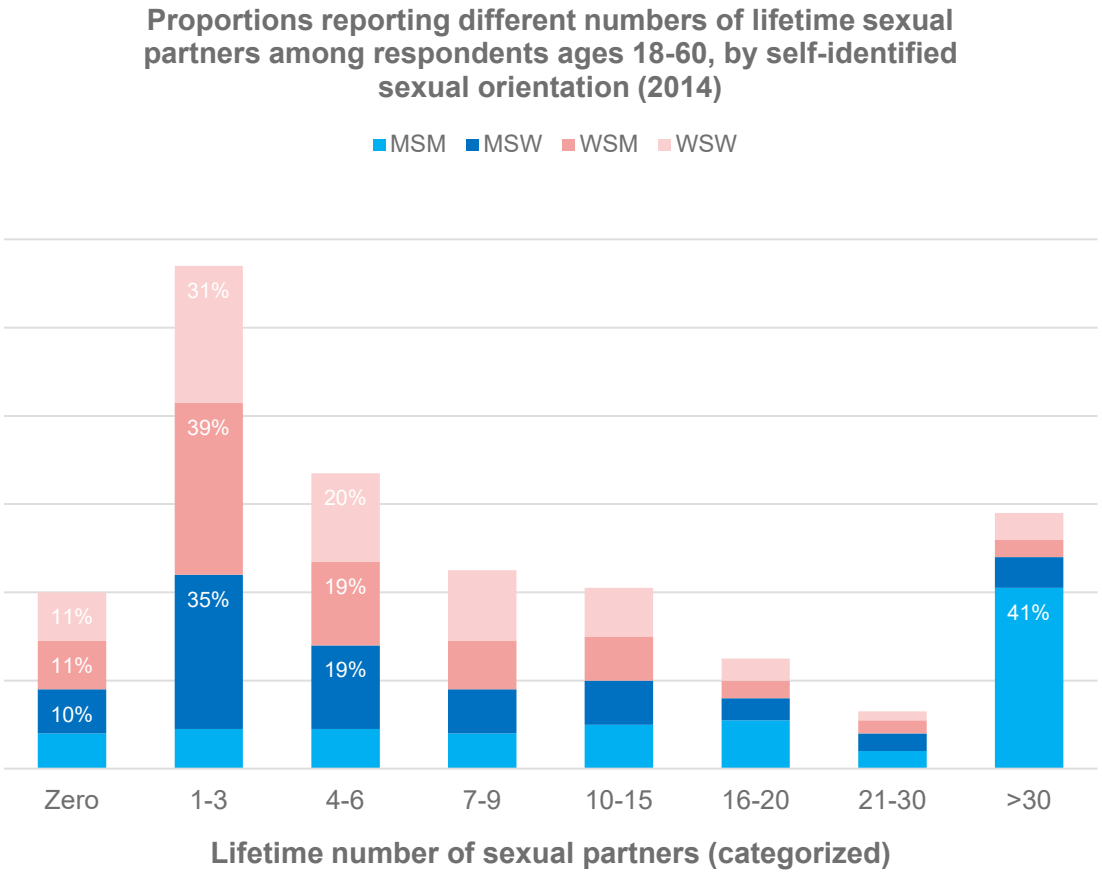
Updated July 30, 2022 at 1:15 p.m. EDT | Published July 30, 2022 at 9:00 a.m. EDT

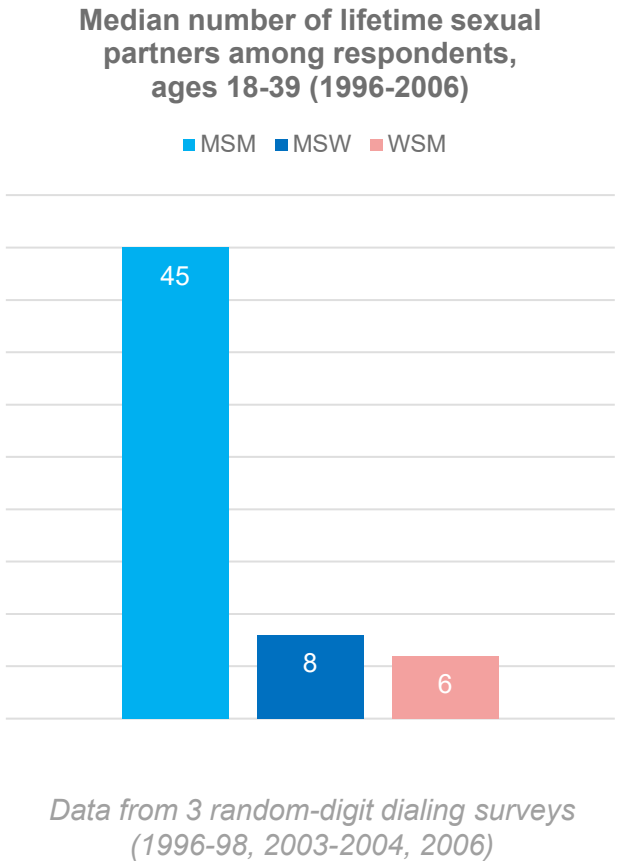
Monkeypox vaccines shown at the Salt Lake County Health Department in Salt Lake City on Thursday. (AP Photo/Rick Bowmer)

“The next shipment of 500,000 Jynneos doses from Bavarian Nordic, the Denmark-based manufacturer, is **not expected until the end of October** amid heavy global demand, said two administration officials who spoke on the condition of anonymity because they were not authorized to speak publicly.”

https://www.washingtonpost.com/health/2022/07/30/monkeypox-jynneos-vaccine-supply-united-states/

MSM have more lifetime sexual partners, on average



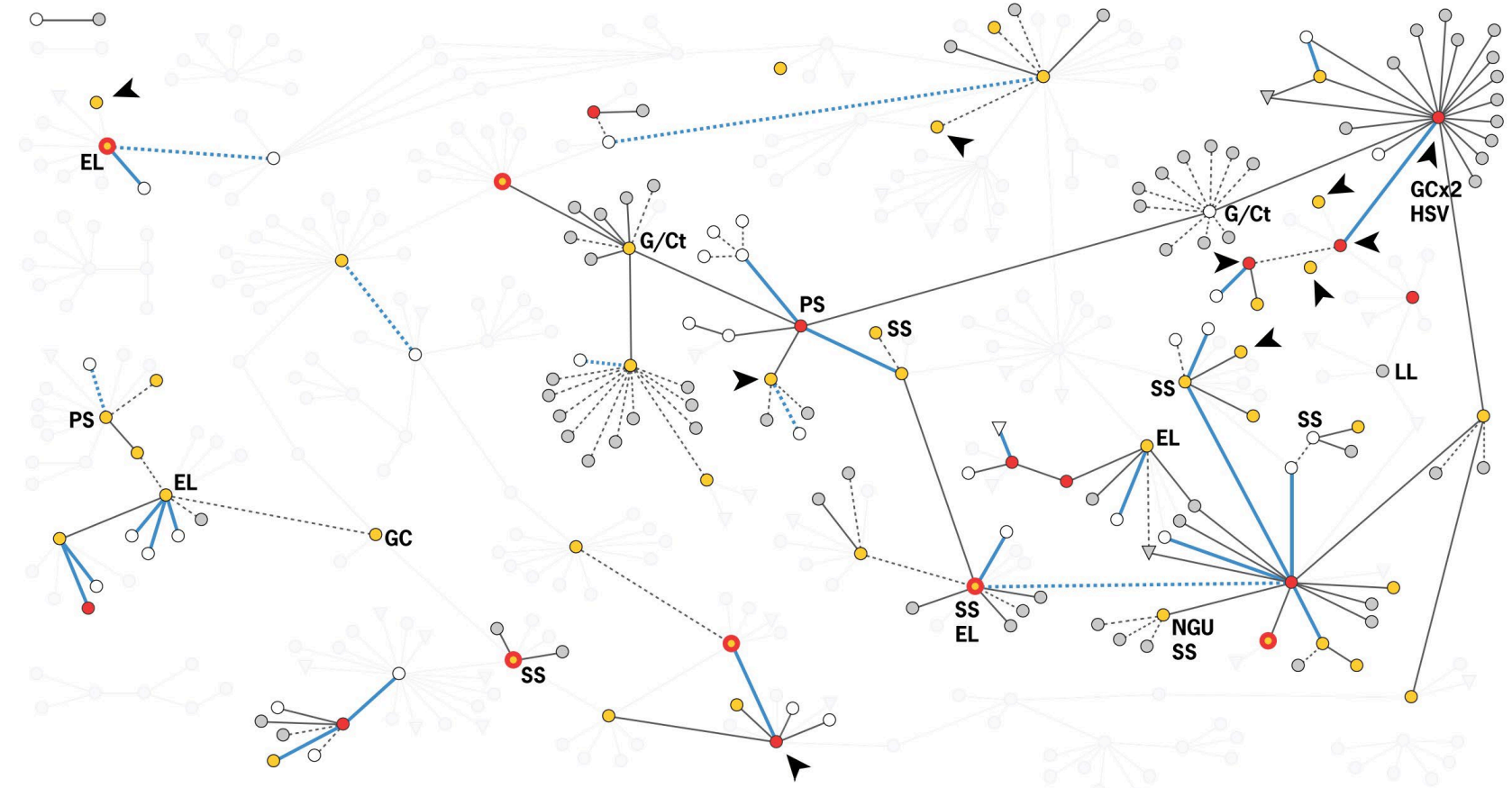


Data from 3 random-digit dialing surveys (1996-98, 2003-2004, 2006)

Glick SN, at al. J Acquir Immune Defic Syndr. 2012 May 1;60(1):83-90. PMID: 22522237; PMCID: PMC3334840
Relationships in America Survey, Austin Institute for the Study of Family and Culture, https://relationshipsinamerica.com/relationships-and-sex/how-many-people-have-americans-had-sex-with

Network structures influence STI outbreaks

Key factor: density of nodes around hubs who are infectious (cores)



2009-2010, North Carolina

Hurt CB, et al. J Acquir Immune Defic Syndr. 2012;61(4):515-21. PubMed PMID: 22972020; PMCID: 3494769
CORE GROUP → Thomas JC, Tucker MJ. J Infect Dis. 1996 Oct;174 Suppl 2:S134-43. PMID: 8843243.

Monkeypox

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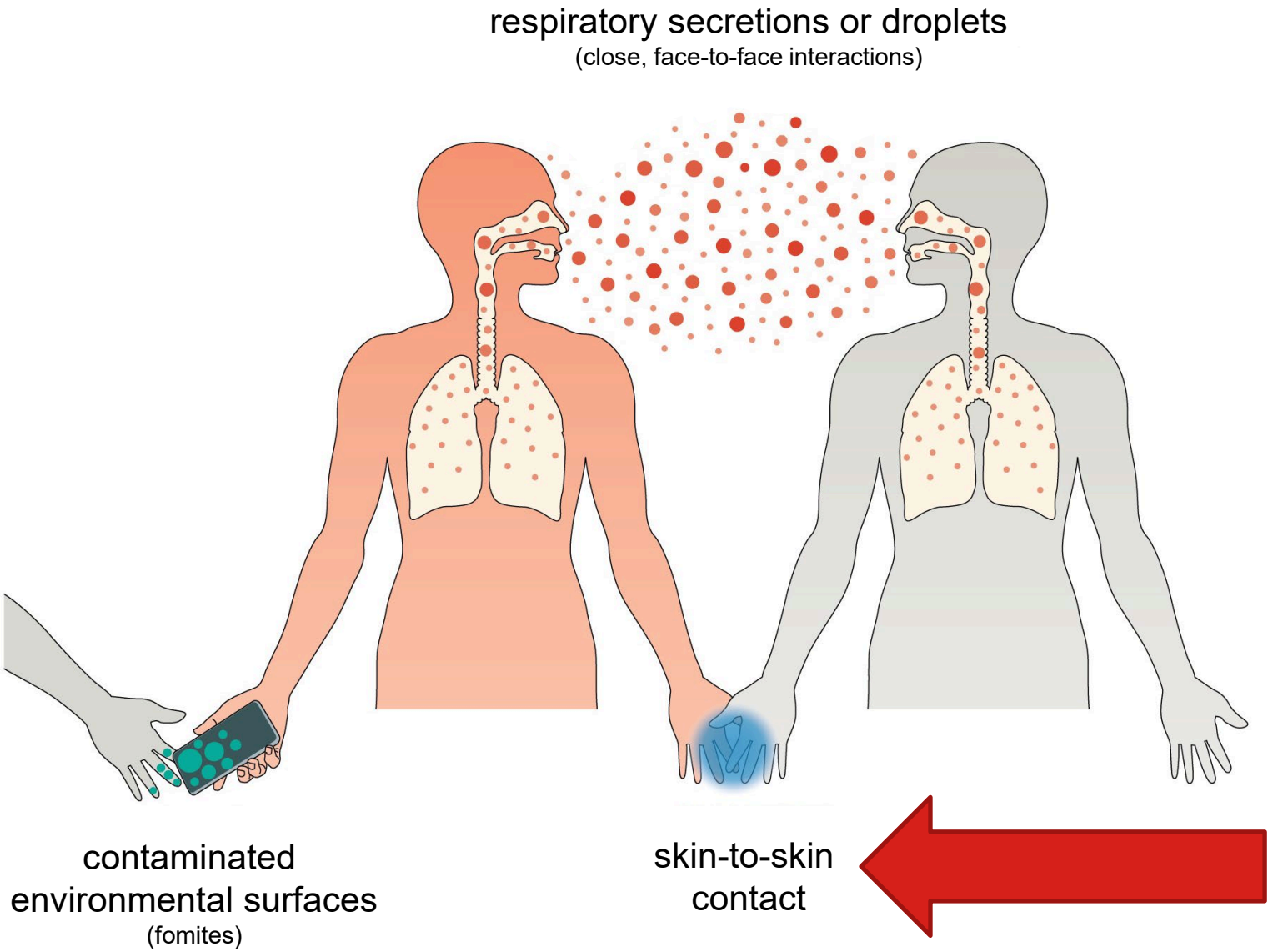
Monkeypox has 3 modes of transmission



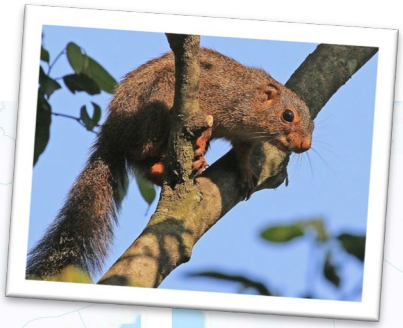
Leung NHL. Nat Rev Microbiol. 2021 Aug;19(8):528-545. PMID: 33753932; PMCID: PMC7982882

Different forms of contact, different risks

@queernation3000

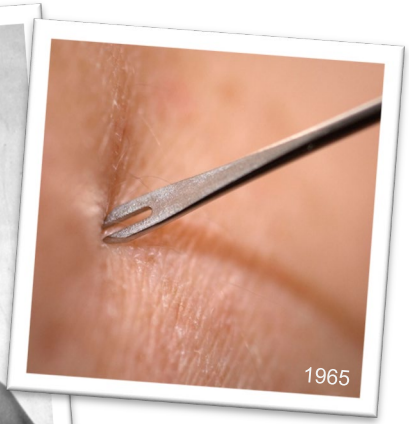
INFOGRAPHIC BASED ON → https://www.nbcchicago.com/news/local/whats-your-risk-of-getting-monkeypox-from-everyday-activities-from-trying-on-clothes-to-attending-a-festival-heres-a-breakdown/2899148/

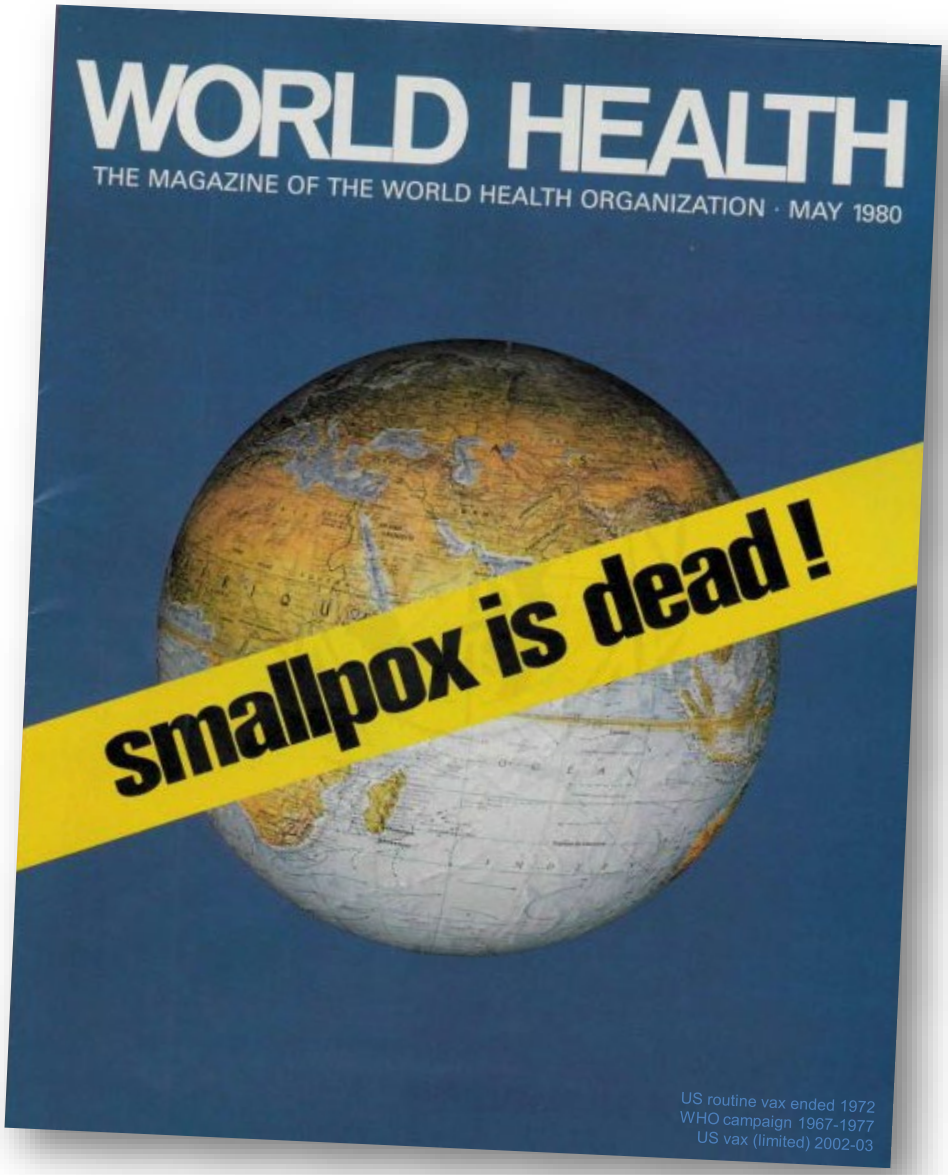
Gaining ground in Africa for decades



MAP → Durski KN, et al. MMWR Morb Mortal Wkly Rep. 2018 Mar 16;67(10):306-310. PMID: 29543790; PMCID: PMC5857192
CHILD → Rimoin AW, et al. Proc Natl Acad Sci U S A. 2010 Sep 14;107(37):16262-7. PMID: 20805472; PMCID: PMC2941342
ANIMALS → https://en.wikipedia.org/wiki/Congo_rope_squirrel#/media/File:Congo_rope_squirrel_(Funisciurus_congicus).jpg https://en.wikipedia.org/wiki/Red-legged_sun_squirrel#/media/File:Red-legged_sun_squirrel_(Heliosciurus_rufobrachium).jpg https://en.wikipedia.org/wiki/Dormouse#/media/File:Graphiurus_spec_-murinus-1.jpg

Smallpox vaccination offered cross-protection

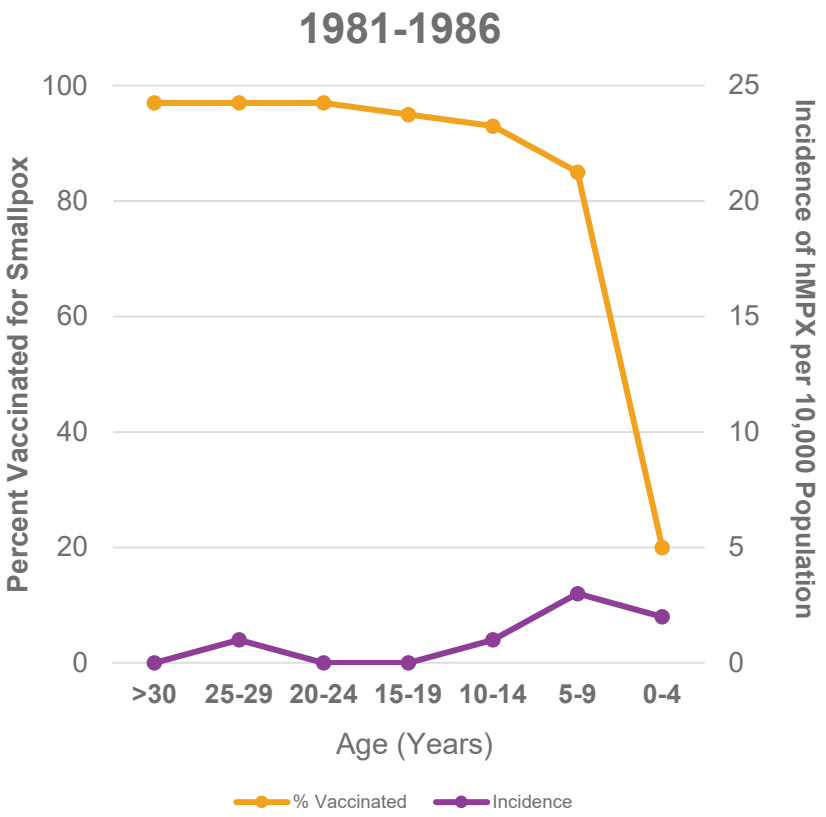


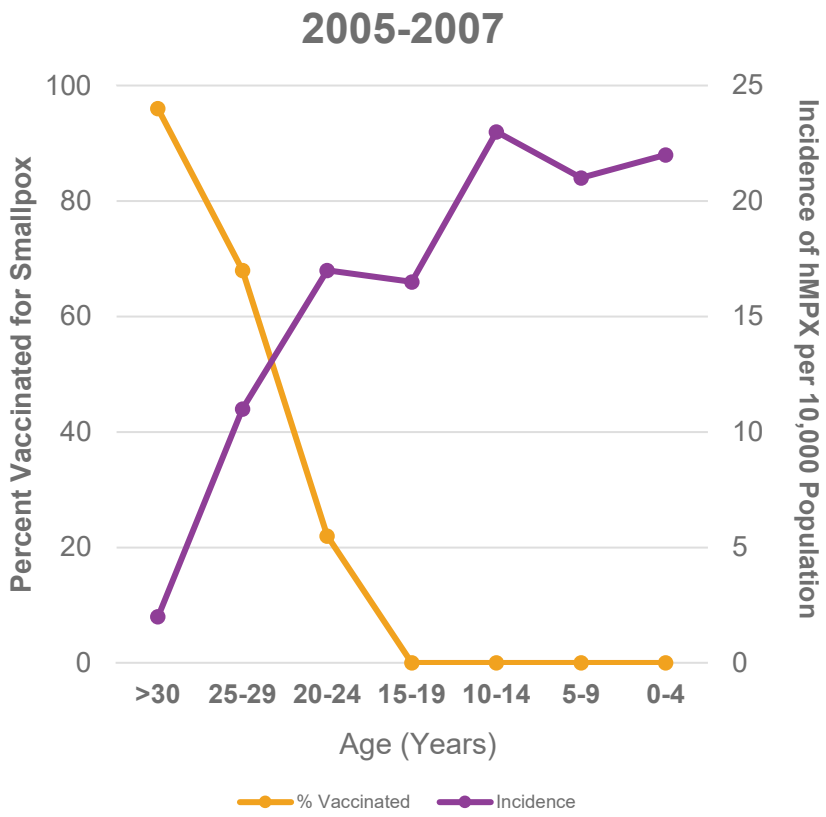


TOP LEFT → https://www.npr.org/2022/05/20/1099830501/smallpox-covid-vaccine-eradication-who
BOTTOM LEFT → https://commons.wikimedia.org/wiki/File:Allan_Warner,_photograph_of_two_boys_with_smallpox_%28Atlas_of_Clinical_Medicine,_Surgery,_and_Pathology,_1901%29_%28cropped%29.jpg
Bifurcated needle → https://globalhealthnow.org/object/bifurcated-needle
Magazine cover → https://twitter.com/DrJennersHouse/status/1242041235331780608

Monkeypox cases rose as smallpox immunity fell

Monkeypox Incidence and Smallpox Vaccine Coverage, Kole Health Zone, DRC





GRAPHS ADAPTED FROM → Lloyd-Smith JO. Philos Trans R Soc Lond B Biol Sci. 2013 Jun 24;368(1623):20120150. PMID: 23798698; PMCID: PMC3720048

Health inequity is the root cause of our outbreak

NEWS | 23 June 2022

Monkeypox in Africa: the science the world ignored

African researchers have been warning about monkeypox outbreaks for years. As vaccines are deployed globally, they worry they will be left behind.

SCIENTIFIC AMERICAN

EPIDEMIOLOGY

'Their Lives Are Worth More Than Ours': Experts in Africa Slam Global Response to Monkeypox

Earlier action by the World Health Organization and Western countries could have helped control monkeypox in Africa

By Paul Adepoju on July 27, 2022

https://www.nature.com/articles/d41586-022-01686-z

https://www.scientificamerican.com/article/lsquo-their-lives-are-worth-more-than-ours-rsquo-experts-in-africa-slam-global-response-to-monkeypox/#

Global spread of the West African clade (2022–)

01 May 2022

Global spread of the West African clade (2022–)

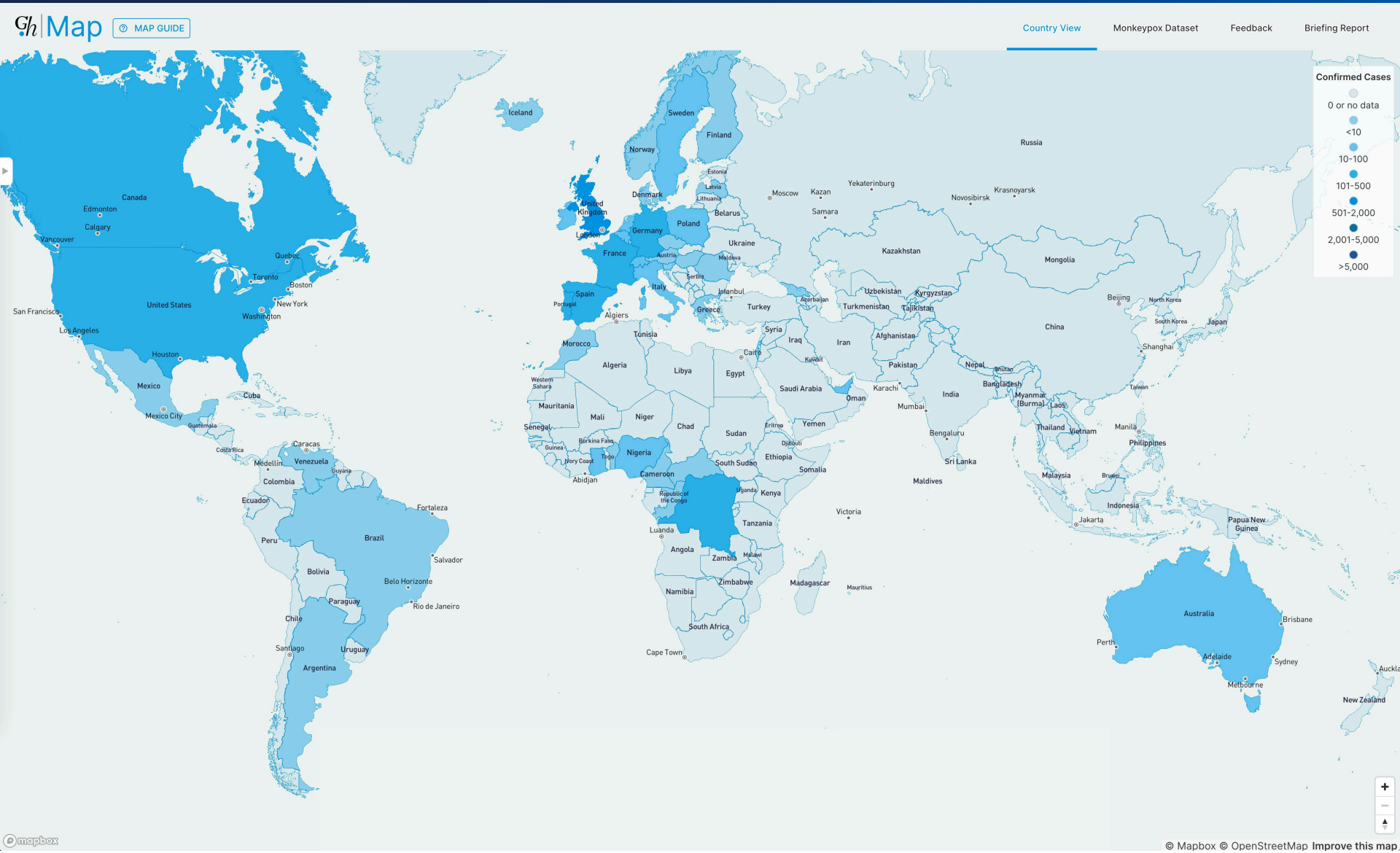
15 May 2022

Global spread of the West African clade (2022–)

01 June 2022

MAPS DOWNLOADED 22 JULY 2022 → https://map.monkeypox.global.health/country

Global spread of the West African clade (2022–)



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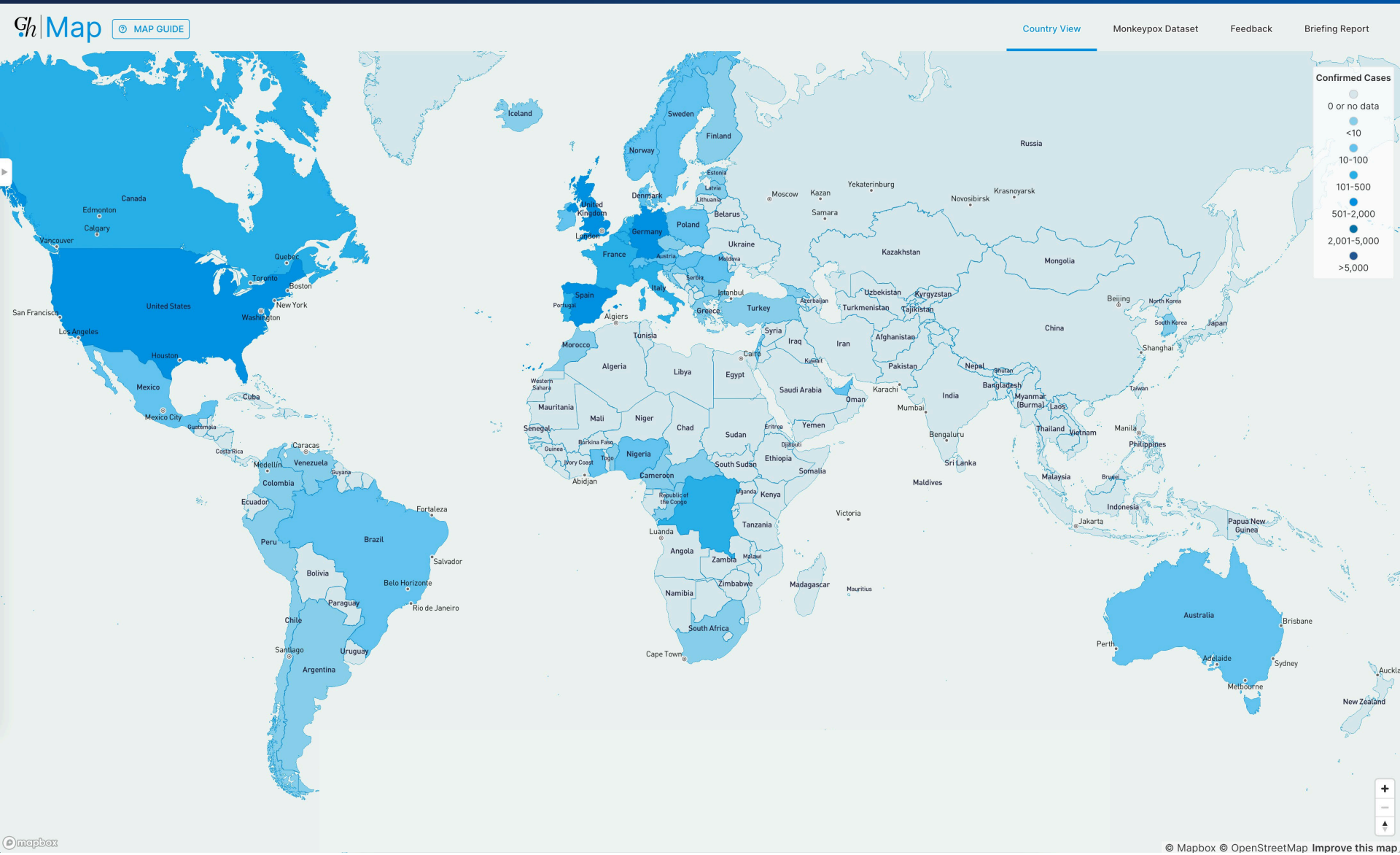

01 July 2022

Global spread of the West African clade (2022–)

15 July 2022

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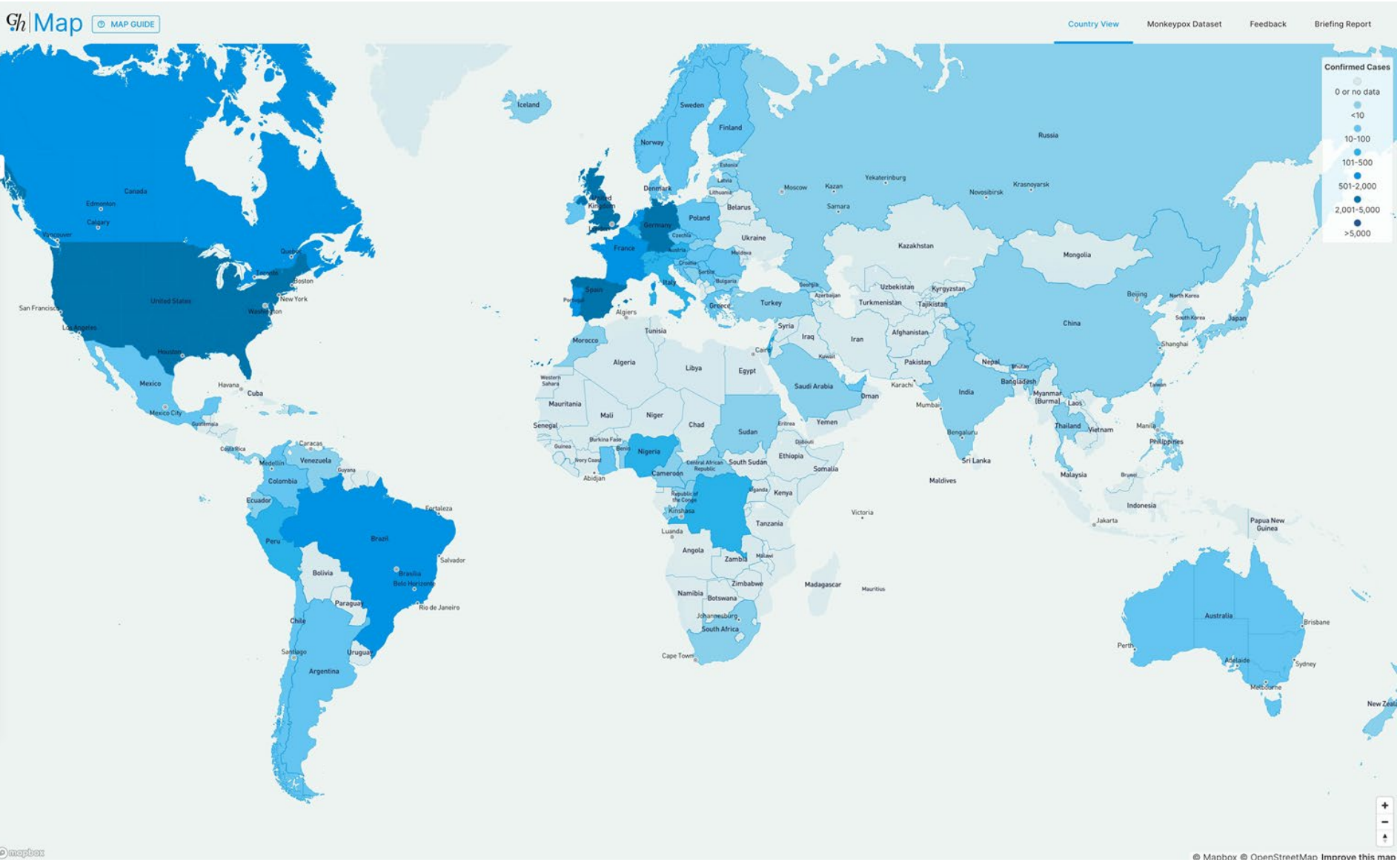


31 July 2022

MAPS DOWNLOADED 22 JULY & 01 AUG 2022 → https://map.monkeypox.global.health/country

Two events were epidemiologically linked to early cases

MASPALOMAS PRIDE

Gran Canaria, 5-15 May

BLANK MAP FROM → https://en.wikipedia.org/wiki/Wikipedia:Blank_maps

Clinical course of monkeypox

"Classical"

- 7-14d incubation (silent)
- Days 0-5: fever, malaise, intense headache, loss of energy, **tender lymph node enlargement**
- Within 3d of fever onset, **"centrifugal" rash** that progresses predictably from macules to crusts
  (face 95%, palms/soles 75%, oral mucosa 70%)
- **Painful** skin lesions (100s-1000s) of **similar size and stage/maturity**
- Case fatality rate around 3%

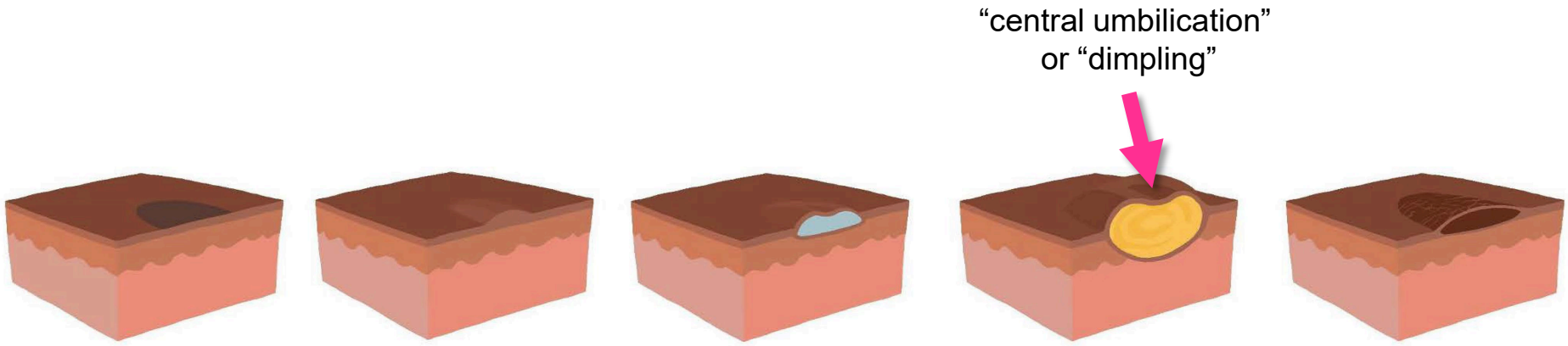
Current outbreak

- 4-17d incubation (mean 8.5d)
- **Absent or delayed prodrome**
- Variable skin presentations
  - Focal crops in/around mouth, perianal area, genitals, body
  - Some cases with no external lesions
- **Asynchrony of lesion stages**
- Relatively few lesions in total
- **Similar with or without HIV**
- **Three deaths (of ~23K cases)**

Patients are contagious until new skin has replaced lesion crusts

CLASSICAL → https://www.who.int/news-room/fact-sheets/detail/monkeypox
CURRENT → https://www.who.int/emergencies/disease-outbreak-news/item/2022-DON396
INCUBATION → Miura F, et al. Euro Surveill. 2022 Jun;27(24):2200448. PMID: 35713026; PMCID: PMC9205160
HIV influence/effect → Thornhill JP, et al. NEJM 22 July 2022 – https://www.nejm.org/doi/full/10.1056/NEJMoa2207323
First deaths → https://www.pinknews.co.uk/2022/07/31/monkeypox-deaths-brazil-spain/

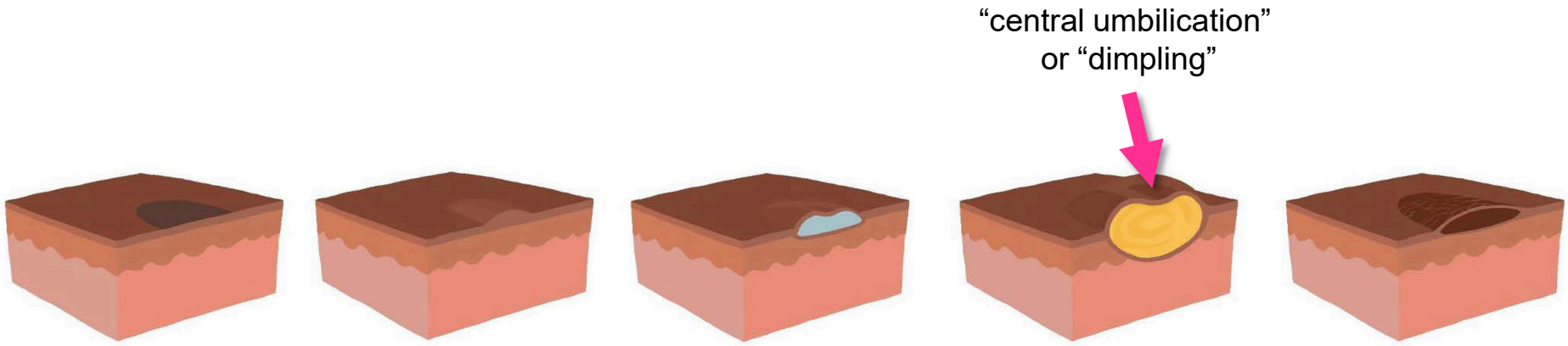
Progression of monkeypox lesions



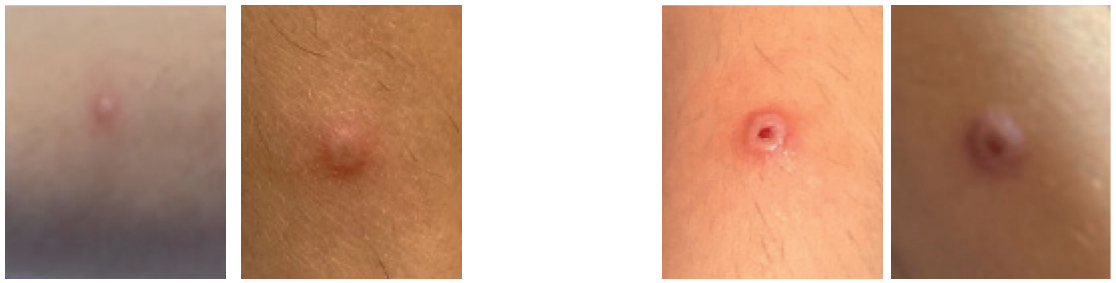
macule papule vesicle pustule crust

DIAGRAM → Titanji, BK. Monkeypox: What Clinicians Need to Know. Slide Deck for IDSA/HIVMA Webinar. https://www.hivma.org/globalassets/hivma/monkeypox-what-clinicians-need-to-know.pdf
CLINICAL IMAGES → Antinori A, et al. Euro Surveill. 2022 Jun;27(22):2200421. PMID: 35656836; PMCID: PMC9164671

Progression of monkeypox lesions



Rapid evolution from macule to scab



Days since first symptom(s) appeared

DIAGRAM → Titanji, BK. Monkeypox: What Clinicians Need to Know. Slide Deck for IDSA/HIVMA Webinar. https://www.hivma.org/globalassets/hivma/monkeypox-what-clinicians-need-to-know.pdf
CLINICAL IMAGES → Antinori A, et al. Euro Surveill. 2022 Jun;27(22):2200421. PMID: 35656836; PMCID: PMC9164671

Representative monkeypox skin lesions

a) early vesicle, 3mm diameter

b) small pustule, 2mm diameter

c) umbilicated pustule, 3-4mm diameter

d) ulcerated lesion, 5mm diameter

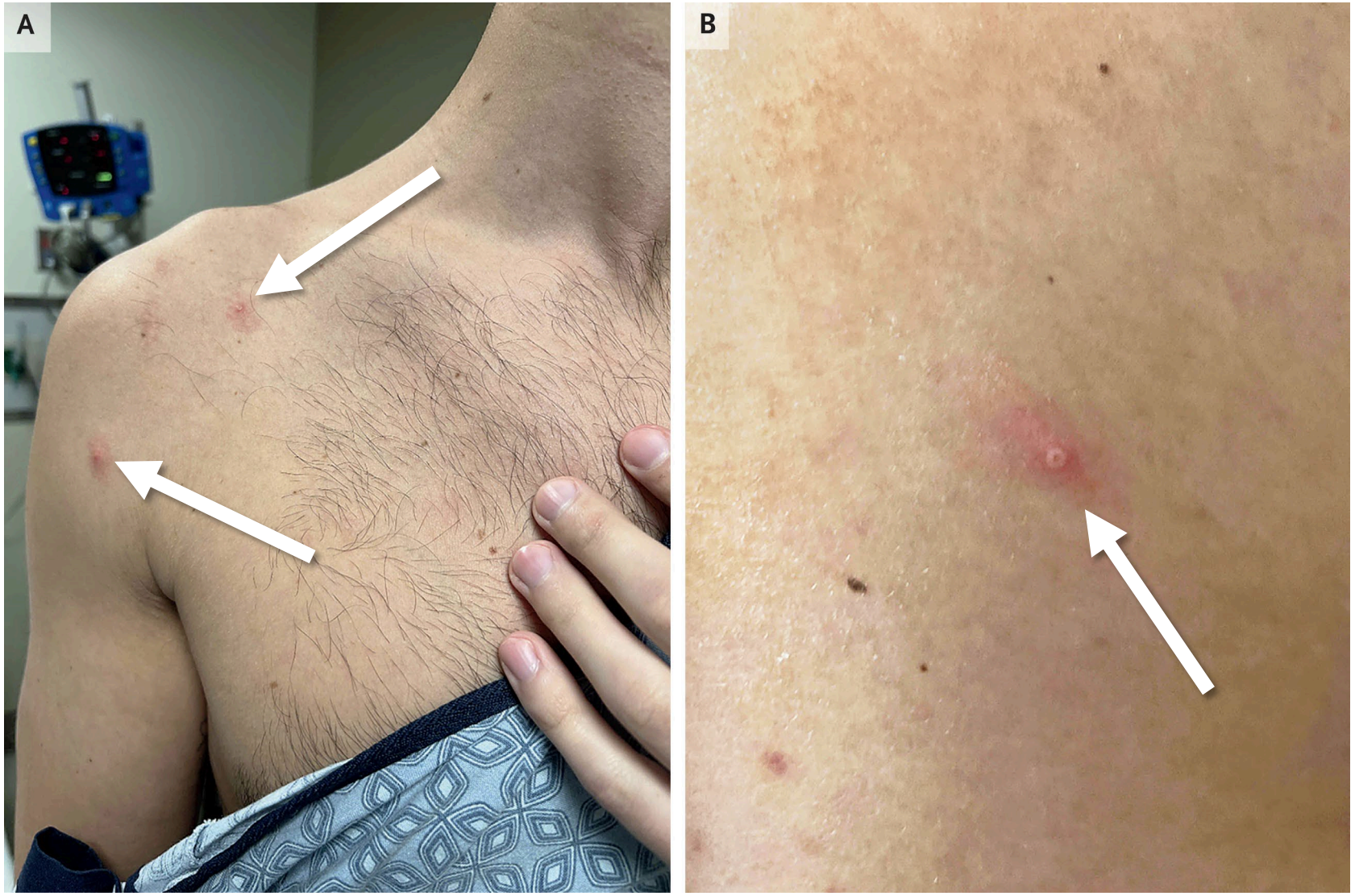
e) crusting of a mature lesion

f) partially removed scab

~18 mm
(lesions shown to scale)

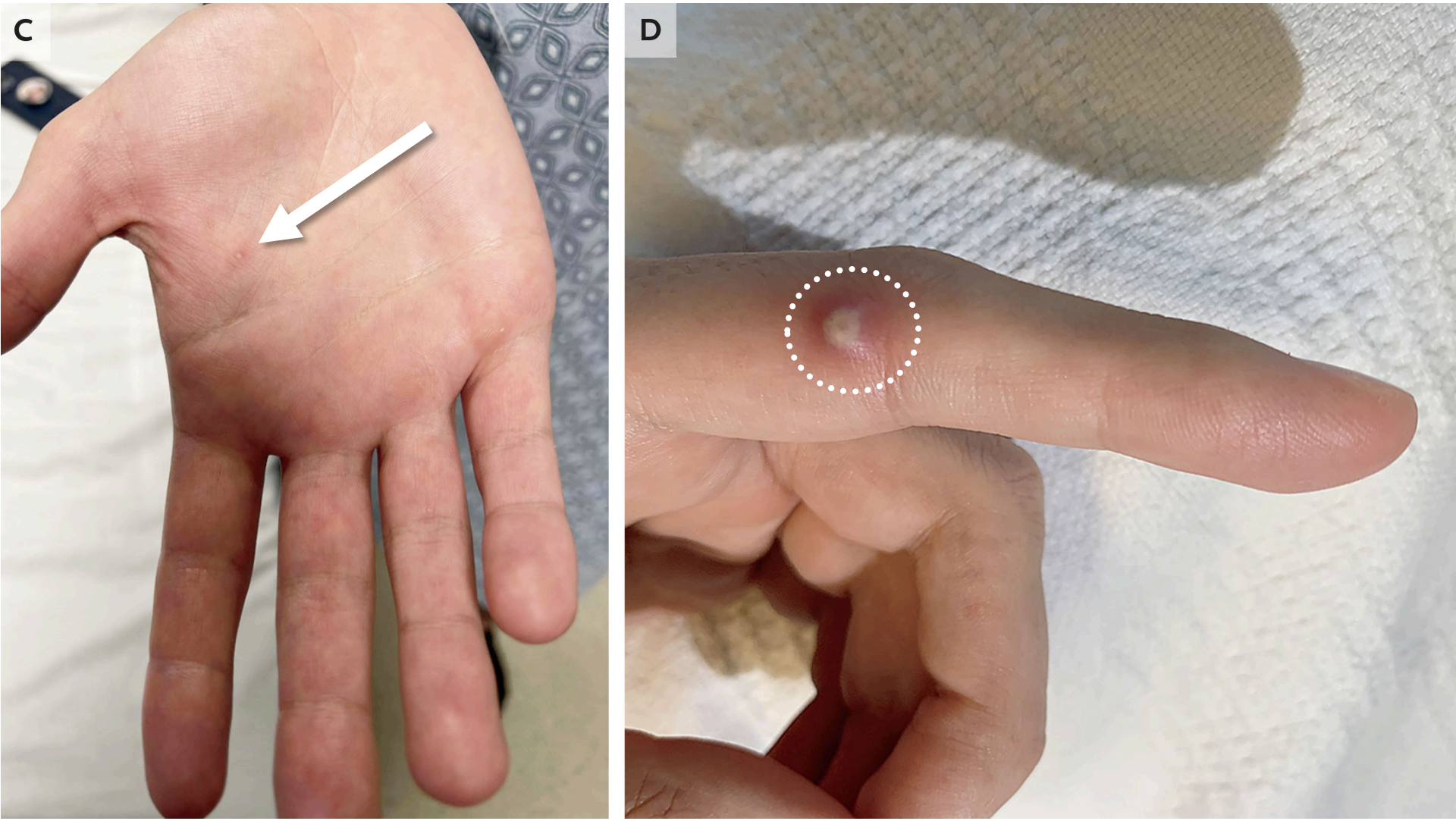
Image from UK Health Security Agency, via → https://news.sky.com/story/monkeypox-how-do-you-catch-it-what-are-the-symptoms-and-how-easily-does-it-spread-12614394
Reverse side of dime → https://commons.wikimedia.org/wiki/File:2017-D_Roosevelt_dime_reverse_transparent.png

31yo on PrEP with recent travel to Canada



Basgoz N, et al. N Engl J Med. 2022 Jun 15. Epub ahead of print. PMID: 35704401

31yo on PrEP with recent travel to Canada



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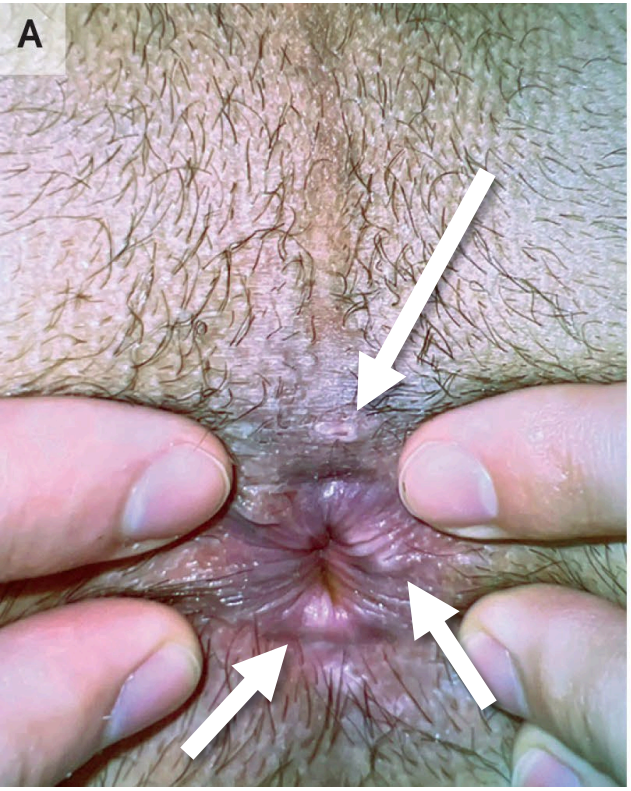


ventral penis

dorsal penis

Basgoz N, et al. N Engl J Med. 2022 Jun 15. Epub ahead of print. PMID: 35704401

31yo Portuguese man with well-controlled HIV

macular (flat) rash
right inguinal area
(with lymphadenopathy)

clustered, umbilicated
pustules on penis
(uncircumcised)

Patrocinio-Jesus R, Peruzzu F. Monkeypox Genital Lesions. N Engl J Med. 2022 Jul 7;387(1):66. doi: 10.1056/NEJMicm2206893. Epub 2022 Jun 15. PMID: 35704421

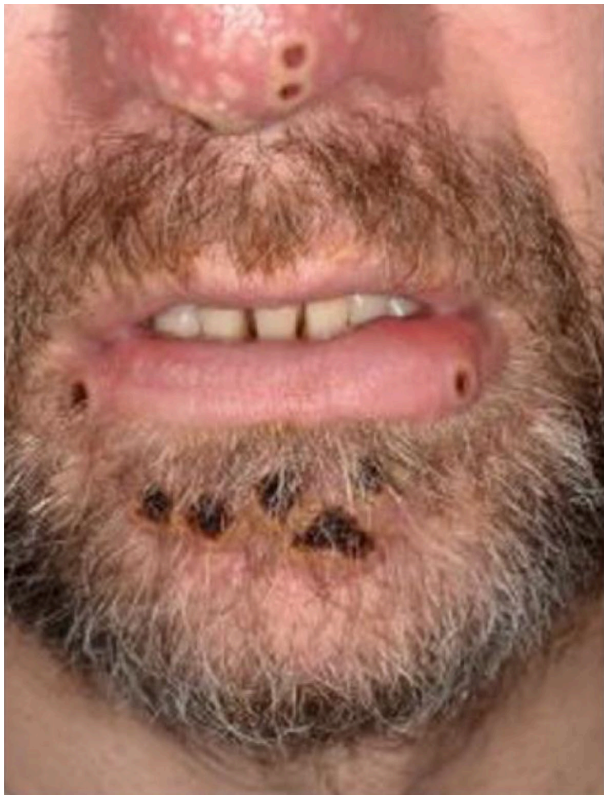
UK patient (partner 1)

multiple lesions on chin
with exuberant crusting

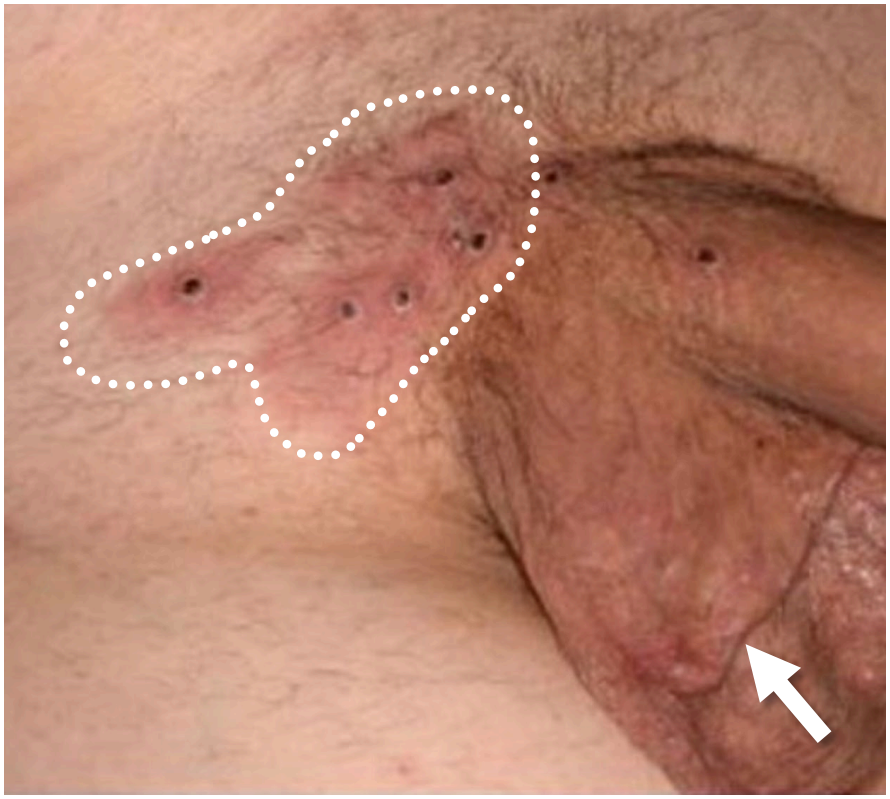
multiple pustular lesions of medial
buttocks, some with coalescence

Patient 1 from → Heskin J, et al. J Infect. 2022 Jun 1:S0163-4453(22)00335-8. Epub ahead of print. PMID: 35659548.

UK patient (partner 2, with well-controlled HIV)



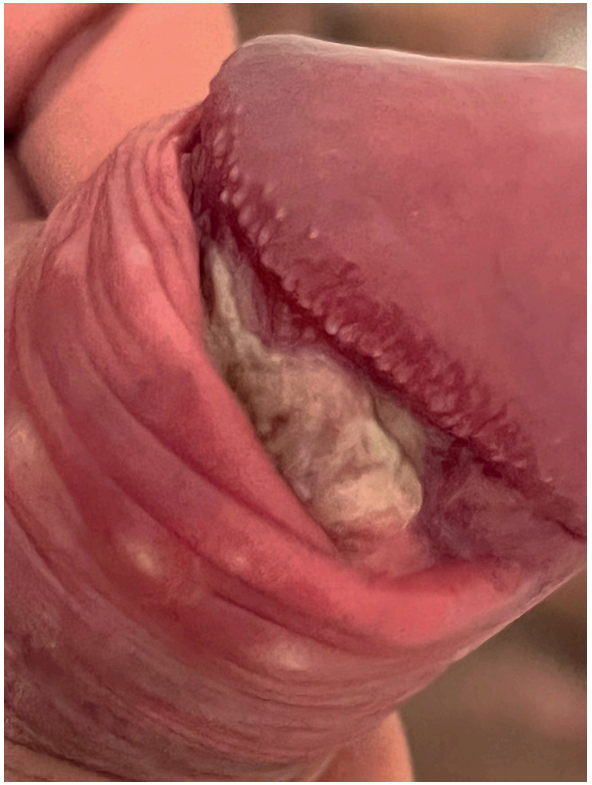
multiple facial lesions



centrally scabbed pustules, each with significant surrounding edema and erythema
(pen line presumably indicates margin of spreading erythema)

Patient 2 from → Heskin J, et al. J Infect. 2022 Jun 1:S0163-4453(22)00335-8. Epub ahead of print. PMID: 35659548.

Adjacent lesions may coalesce before ulcerating



multiple lesions on shaft
and coalescence in sulcus
(papules on edge of corona are a benign finding)

perianal lesions coalescent into an area of ulceration
(same patient, 10 days apart)

Girometti N, et al. Lancet Infect Dis. 2022. https://doi.org/10.1016/ S1473-3099(22)00411-X

Maintaining a high index of suspicion is **essential**.

If you see something, test something!

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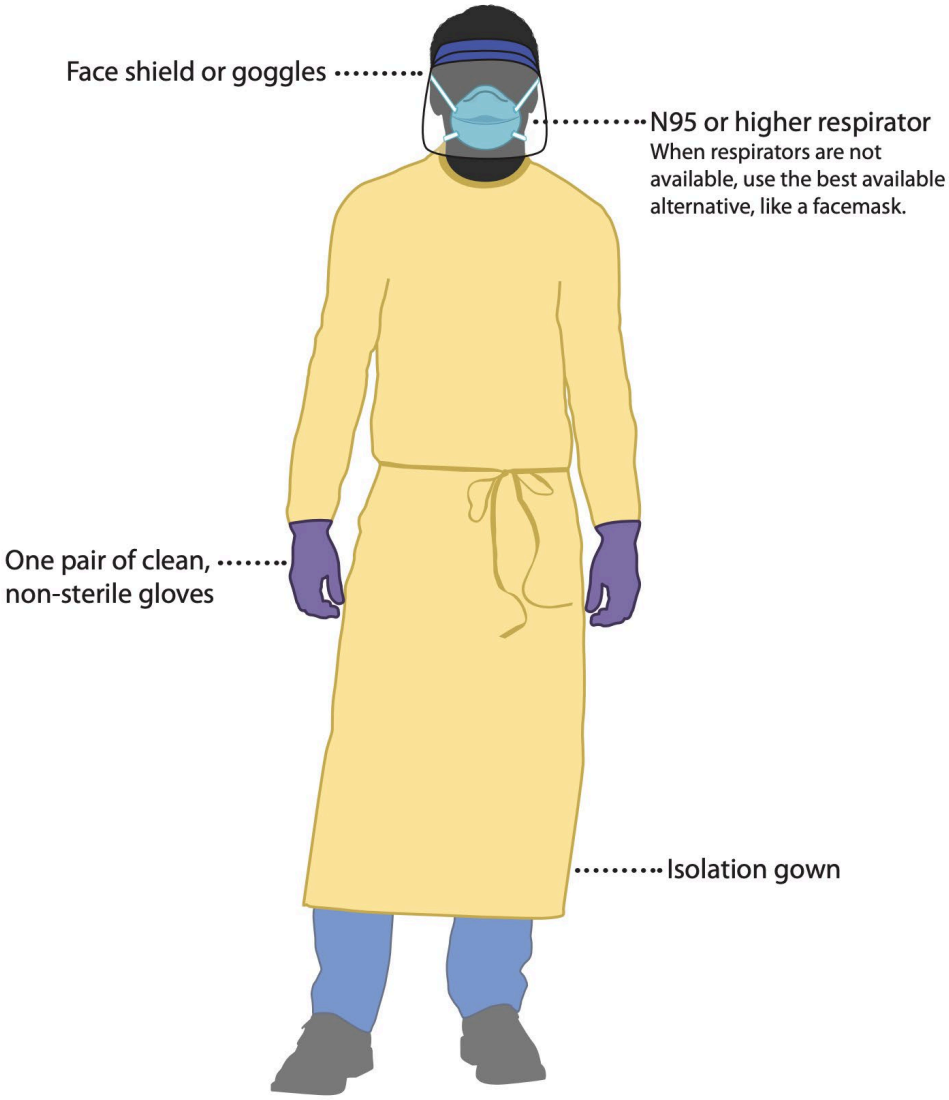
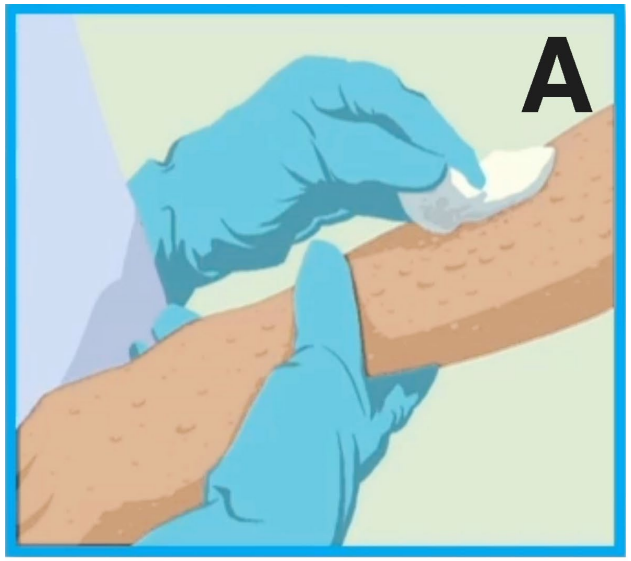
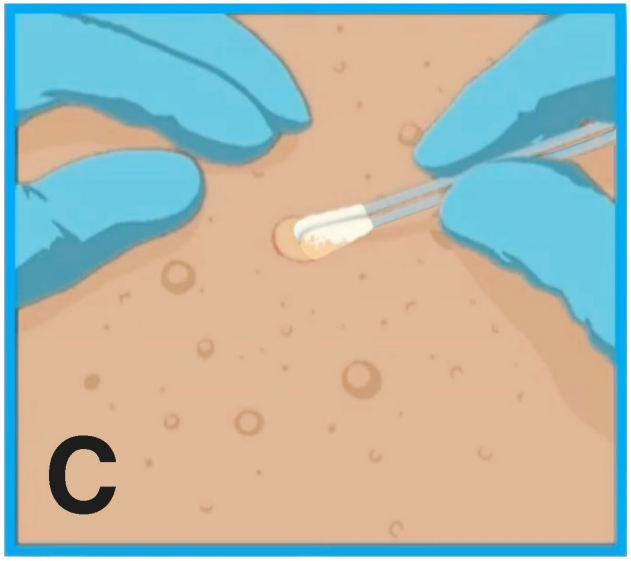
Collecting a specimen for monkeypox testing

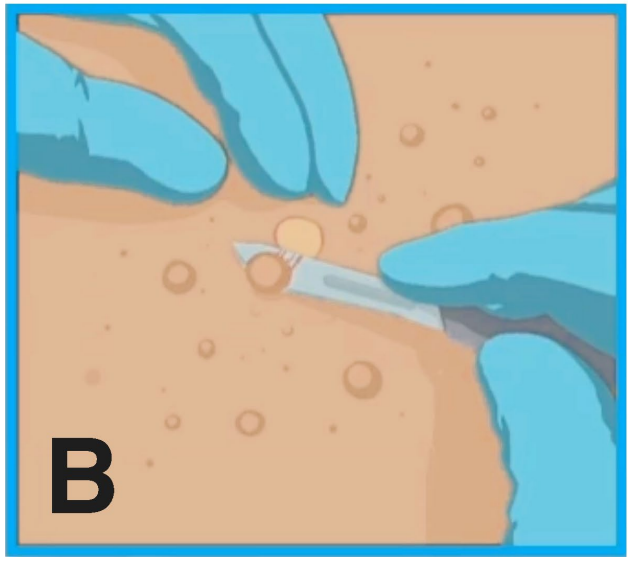


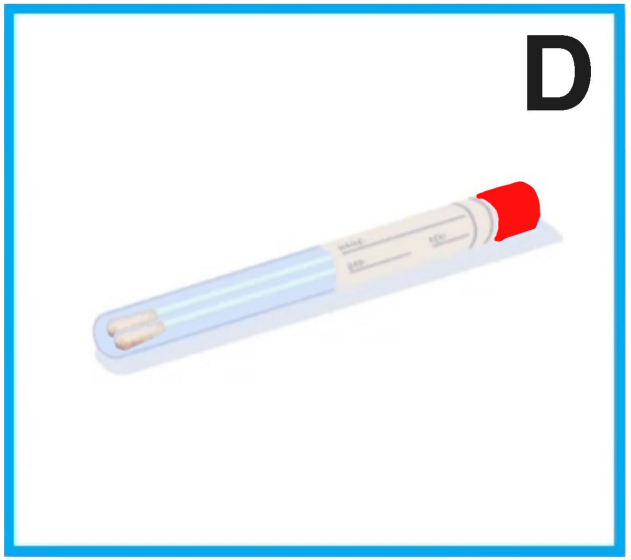
https://www.cdc.gov/coronavirus/2019-ncov/downloads/A_FS_HCP_COVID19_PPE.pdf

Collecting a specimen for monkeypox testing









x2

Clinical management

For exposures: urgent immunization

- **Given within 4d of exposure, may prevent onset**
- Given within 4-14d of exposure, may mitigate severity of disease

For most patients: supportive care alone

- **Aggressive / liberal pain management**
- Isolation to avoid transmission (21 days)

For patients at risk of highly morbid or severe disease

- "Medical countermeasures" available with CDC consultation
  - **Tecovirimat** (TPOXX; oral or intravenous) → → →
  - **Vaccinia immune globulin** (VIGIV; intravenous)
  - **Brincidofovir** (TEMBEXA; tablets or oral suspension)
  - **Cidofovir** (VISTIDE; intravenous)

https://www.cdc.gov/poxvirus/monkeypox/clinicians/treatment.html

Immunization will be key to long-term control

JYNNEOS (replication-deficient, live *Vaccinia* virus)

- Licensed in 2019 for persons with occupational risk of exposure
- Two-shot series administered subcutaneously, 28d apart
  - If at ongoing occupational risk, booster is needed every 2 years

ACAM2000 (replication-competent, live *Vaccinia* virus)

- Licensed 2007 for occupational exposures and military personnel
- Administered using “scarification” technique (bifurcated needle)
- Significant risk of serious adverse events
  - **Myopericarditis** (5.7 cases per 1000 vaccinees)
  - Progressive vaccinia disease
  - Eczema vaccinatum

https://www.cdc.gov/poxvirus/monkeypox/clinicians/smallpox-vaccine.html

Rao AK, et al. MMWR Morb Mortal Wkly Rep. 2022 Jun 3;71(22):734-742. PMID: 35653347; PMCID: PMC9169520

What about people with HIV?

JYNNEOS (replication-deficient, live *Vaccinia* virus)

- Studied among people with HIV (CD4 counts 200-750 cells/μL)
- No differences in safety profile among people with HIV
- Immunogenicity was comparable

ACAM2000 (replication-competent, live *Vaccinia* virus)

- **No studies among people with HIV**
- PI: "Severe localized or systemic infection with vaccinia … may occur in persons with weakened immune systems, including … HIV/AIDS"
- 2015 CDC bioterrorism guidance: persons with CD4 counts <50 cells/μL are less likely to respond, more likely to have adverse effects
  - Relative contraindication if CD4 50-199, for a ***smallpox*** outbreak

JYNNEOS among PwH → Overton ET, et al. Open Forum Infect Dis. 2015 May 5;2(2):ofv040. PMID: 26380340; PMCID: PMC4567089
ACAM2000 package insert → https://www.fda.gov/media/75792/download
ACAM2000 for PwH → Petersen BW, et al. MMWR Recomm Rep. 2015 Feb 20;64(RR-02):1-26. PMID: 25695372

Meningococcus

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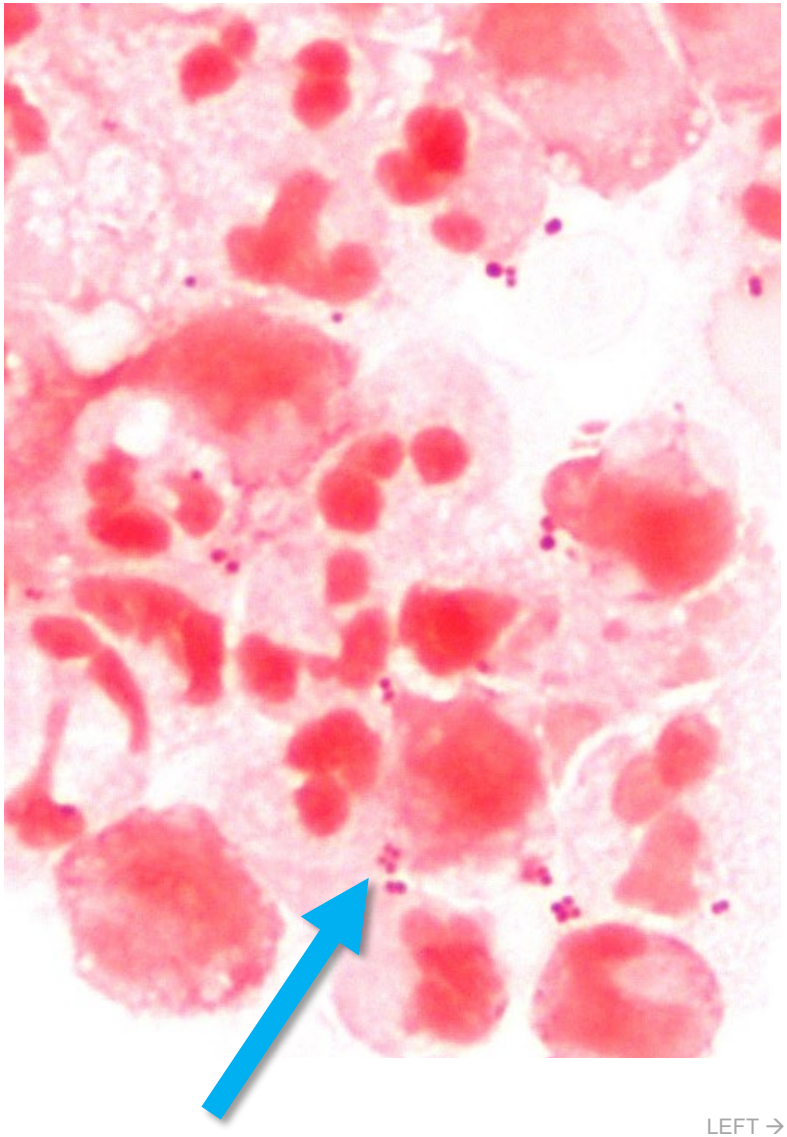
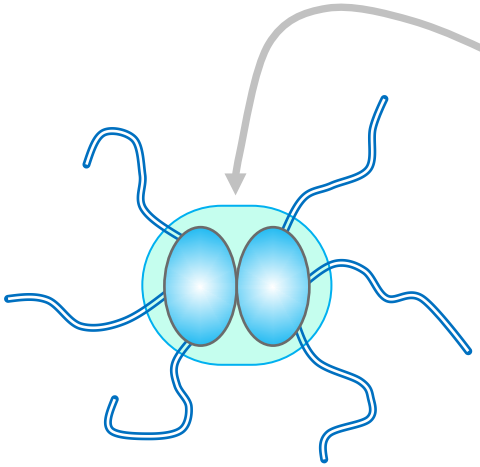
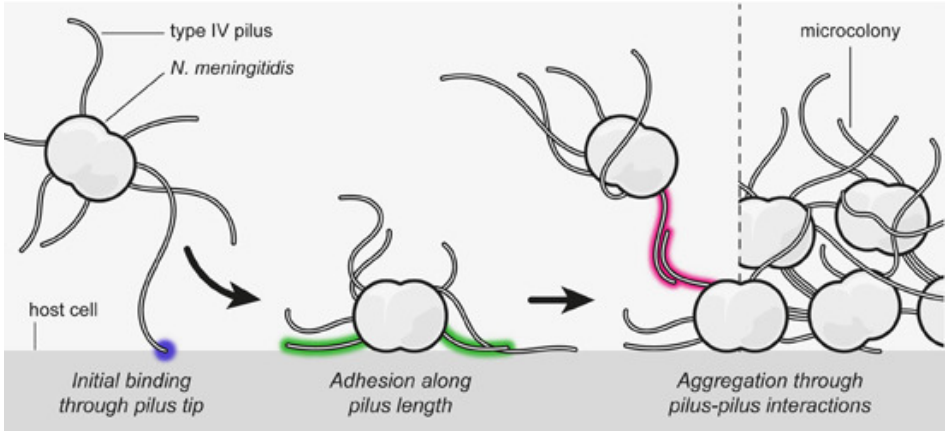
Neisseria meningitidis (*Nm*) is a bacterium



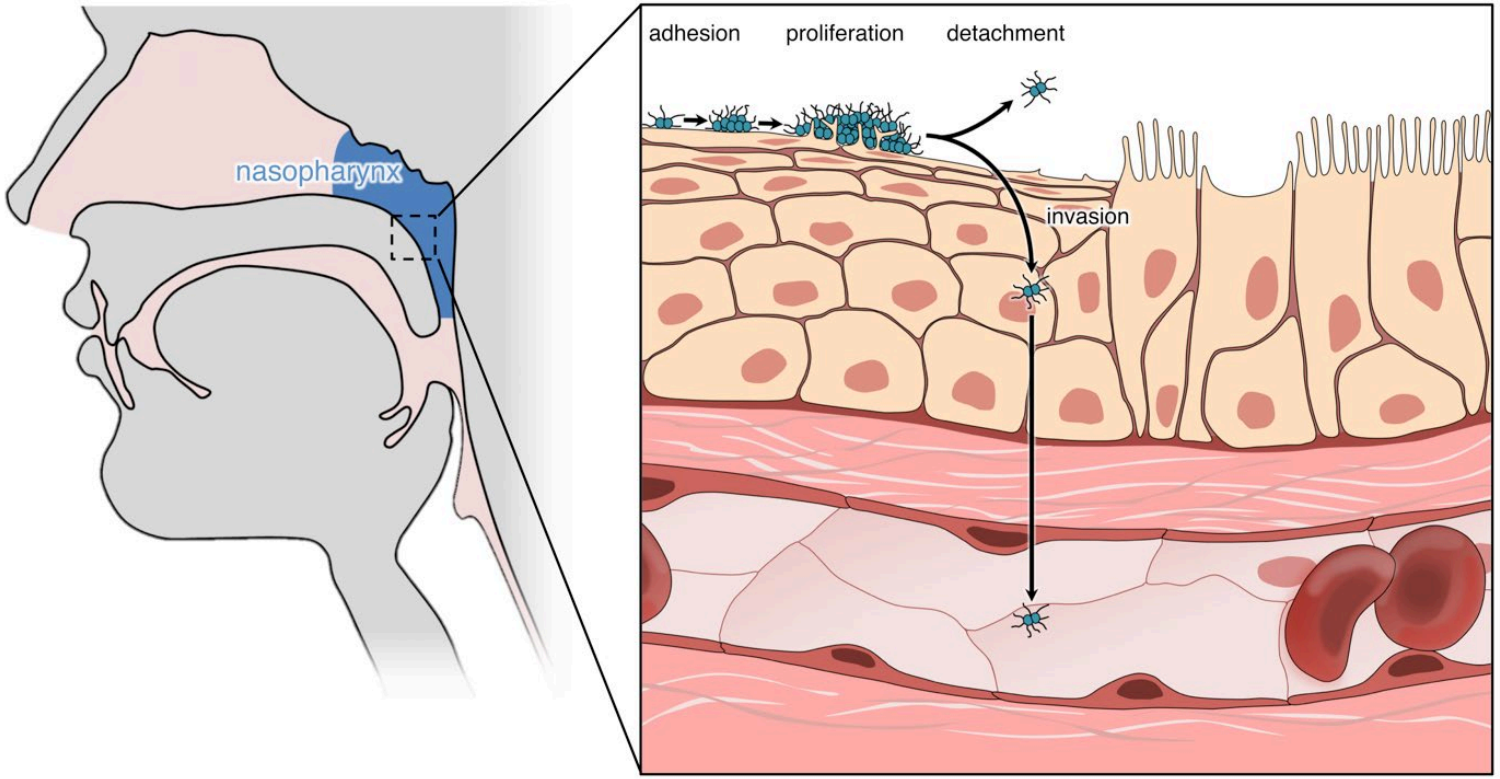


- Serogrouping based on polysaccharide capsule composition
- A, B, C, W, X, and Y
- Serogroups B, C, and Y responsible for most cases in US (“MenB,” “MenC”)



LEFT → https://en.wikipedia.org/wiki/Neisseria_meningitidis#/media/File:Neisseria_meningitidis_CSF_Gram_1000.jpg
TOP → illustration by Christopher Hurt
BOTTOM → Kennouche P, et al. EMBO J. 2019 Nov 15;38(22):e102145. PMID: 31609039; PMCID: PMC6856618

Transmission primarily via respiratory droplets

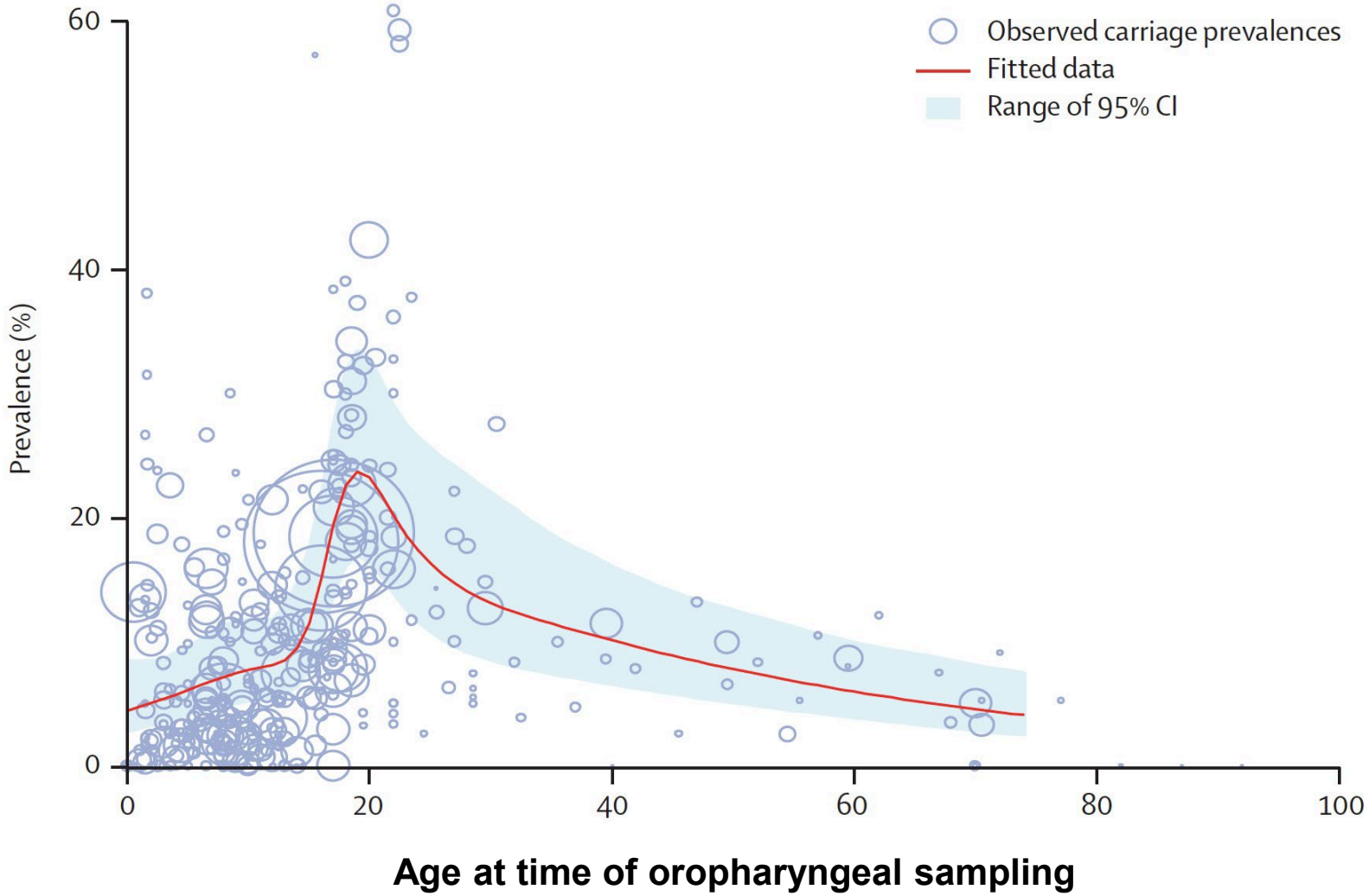


Three potential outcomes: transient attachment, carriage, and invasive meningococcal disease (IMD).

Carriage is an immunity-inducing event for the host.

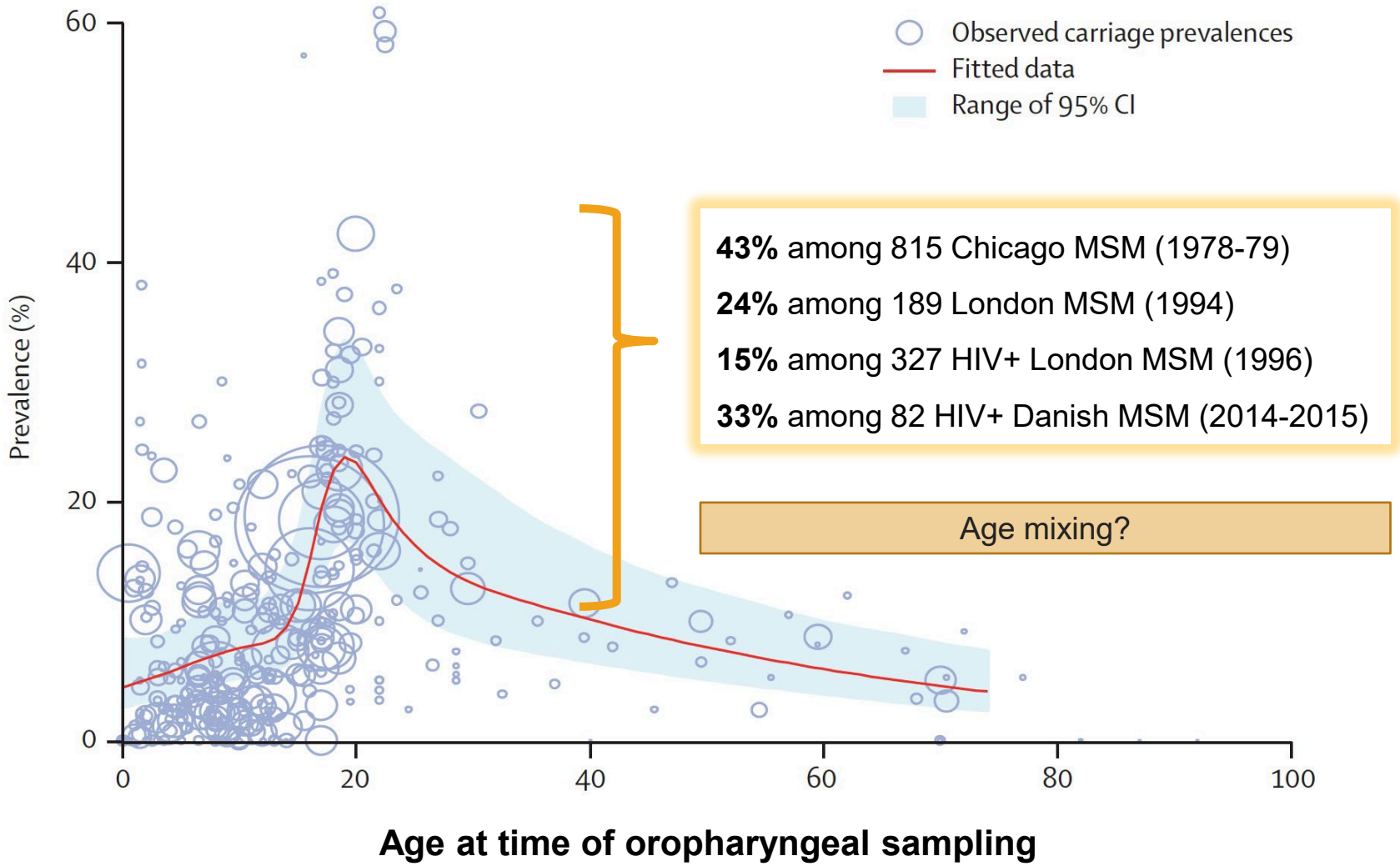
https://www.researchgate.net/publication/332961532_Cellular_and_molecular_mechanisms_of_human_endothelial_cell_plasma_membrane_remodeling_by_Neisseria_meningitidis/figures?lo=1

General population carriage peaks by age 20



Christensen H, et al. Lancet Infect Dis. 2010 Dec;10(12):853-61. PMID: 21075057

Carriage rates are higher among MSM at any age



43% among 815 Chicago MSM (1978-79)

24% among 189 London MSM (1994)

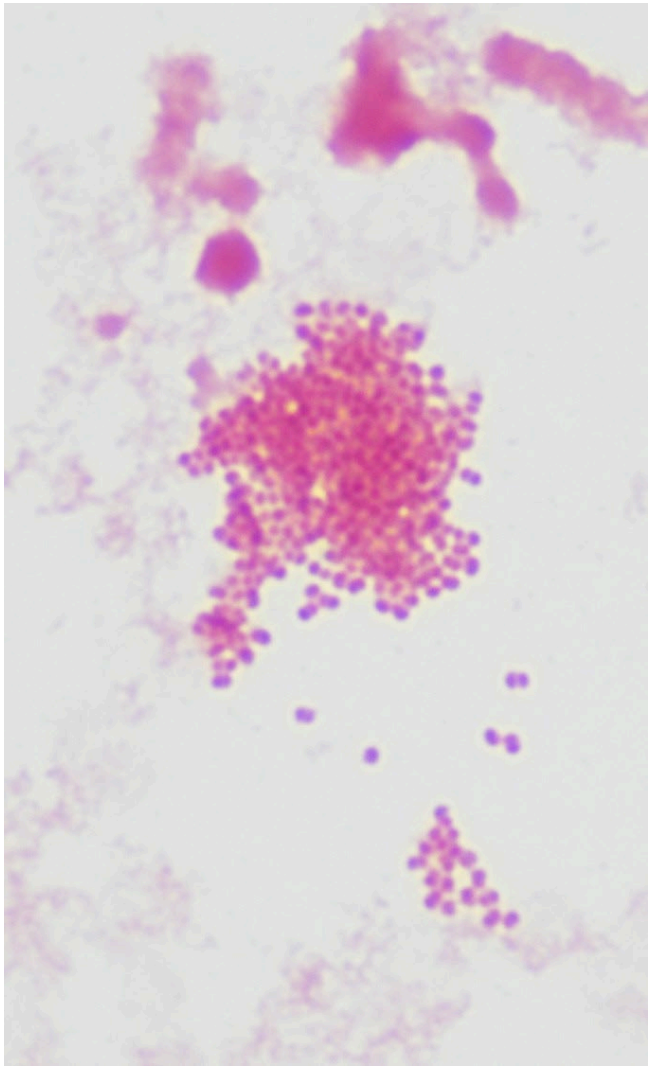
15% among 327 HIV+ London MSM (1996)

33% among 82 HIV+ Danish MSM (2014-2015)

Age mixing?

Janda WM, et al. JAMA. 1980 Nov 7;244(18):2060-4. PMID: 6776296
Russell JM, et al. Int J STD AIDS. 1995 May-Jun;6(3):211-5. PMID: 7647127
Carlin EM, et al. Genitourin Med. 1997 Dec;73(6):477-80. PMID: 9582465; PMCID: PMC1195929
Tinggaard M, et al. Int J Infect Dis. 2021 Apr;105:337-344. PMID: 33610779
Christensen H, et al. Lancet Infect Dis. 2010 Dec;10(12):853-61. PMID: 21075057

Invasive MenC emerged among MSM in 2001

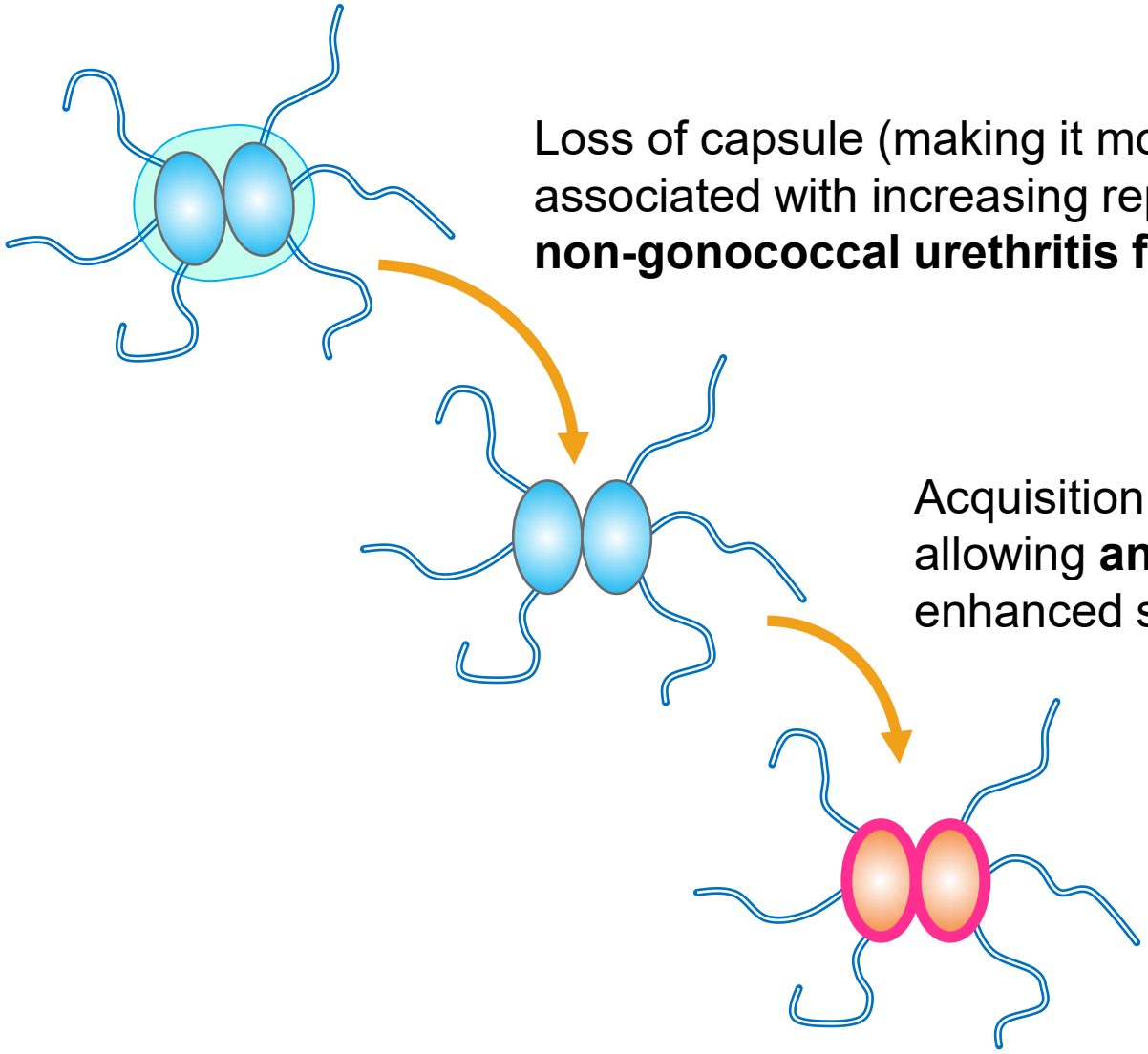


Location	Year	Cases	Fatality Rate
Toronto	2001	6	33%
Chicago	2003	6	50%
NYC	2010-13	22	32%
Berlin	2012-13	5	40%
Paris	2013	36	17%
LA	2012-14	13	38%
Chicago	2015-16	9	11%
Tuscany	2015-16	62	21%
California	2016	25	8%
Melbourne	2017	8	?
Florida	**2022**	**24** [48?]	**25%**

Majority of cases are associated with hypervirulent lineage (11.2) of sequence type / clonal complex 11

IMAGE → Brostowski LE, Graf EH. J Clin Microbiol. 2019 Jan 30;57(2):e01513-18. PMID: 30700562; PMCID: PMC6355521
TABLE ADAPTED FROM → Ladhani SN, et al. Lancet. 2020 Jun 13;395(10240):1865-1877. PMID: 32534649

Nm clonal complex 11 is an emerging STI



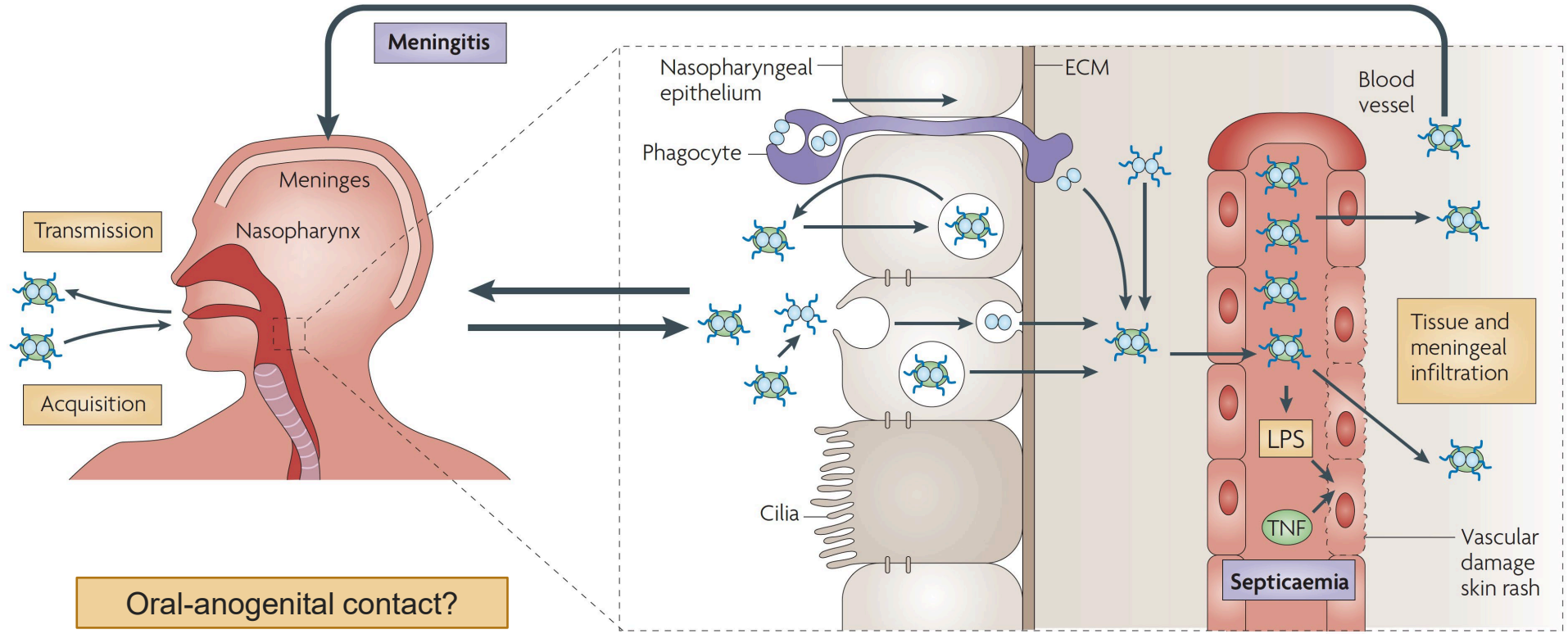
Loss of capsule (making it more like *N. gonorrhoeae*) associated with increasing reports of **non-gonococcal urethritis from *Nm*** (2015–)

Acquisition of genes (from GC?) allowing **anaerobic growth** (*aniA*) and enhanced survival in blood (fHbp)

Tzeng YL, et al. Proc Natl Acad Sci U S A. 2017 Apr 18;114(16):4237-4242. PMID: 28373547; PMCID: PMC5402416
Bazan JA, et al. MMWR Morb Mortal Wkly Rep. 2016 Jun 3;65(21):550-2. PMID: 27254649; PMCID: PMC5390329
Ladhani SN, et al. Lancet. 2020 Jun 13;395(10240):1865-1877. PMID: 32534649

Illustration by Christopher Hurt

MenC cc11 is well-equipped to cause IMD among MSM



Carriage with cc11 is infrequent → transient attachment or invasion

POOR CARRIAGE → Miglietta A, et al. BMC Infect Dis. 2019 Jan 8;19(1):29. PMID: 30621624; PMCID: PMC6323866
DIAGRAM → Virji M. Nat Rev Microbiol. 2009 Apr;7(4):274-86. PMID: 19287450
REVIEW IMPLICATING ORAL SEX → Ladhani SN, et al. Lancet. 2020 Jun 13;395(10240):1865-1877. PMID: 32534649

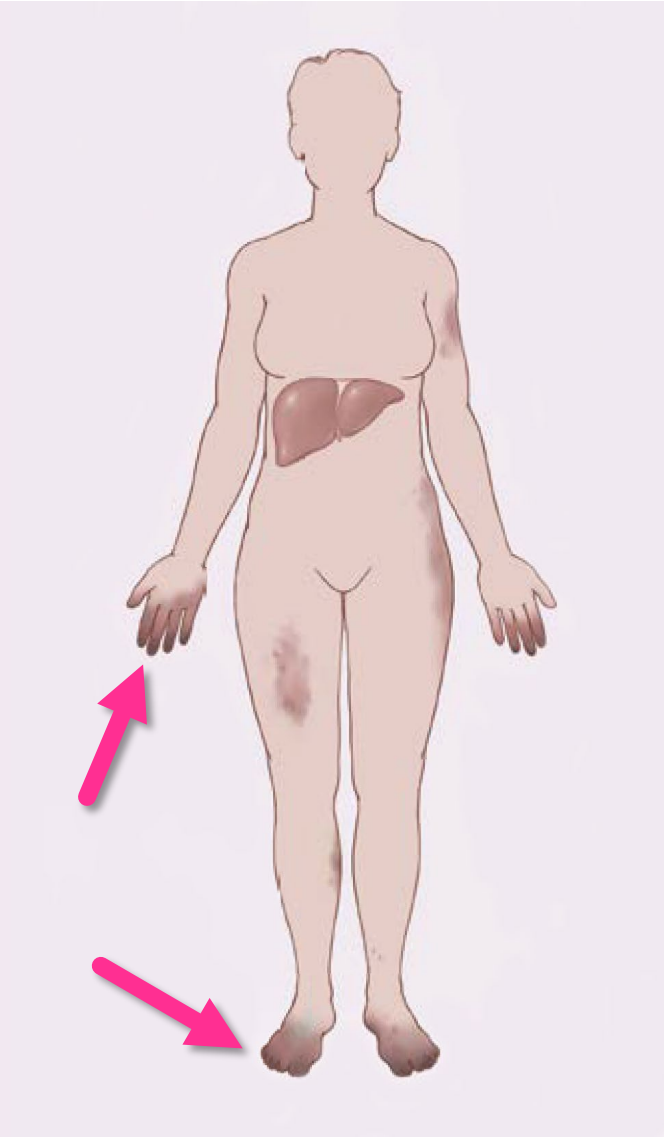
Clinical course of IMD

Dramatic, rapid progression from usual state of health to severe headache to hospitalization (hours)

- Silent incubation for up to 10 days (during which they are contagious)
- Truly sudden onset of fever, nausea/vomiting, headache, muscle pain
- Neck stiffness (meningismus) and impaired consciousness follow
- Sepsis physiology sets in, with **hypotension** and **hemorrhages**

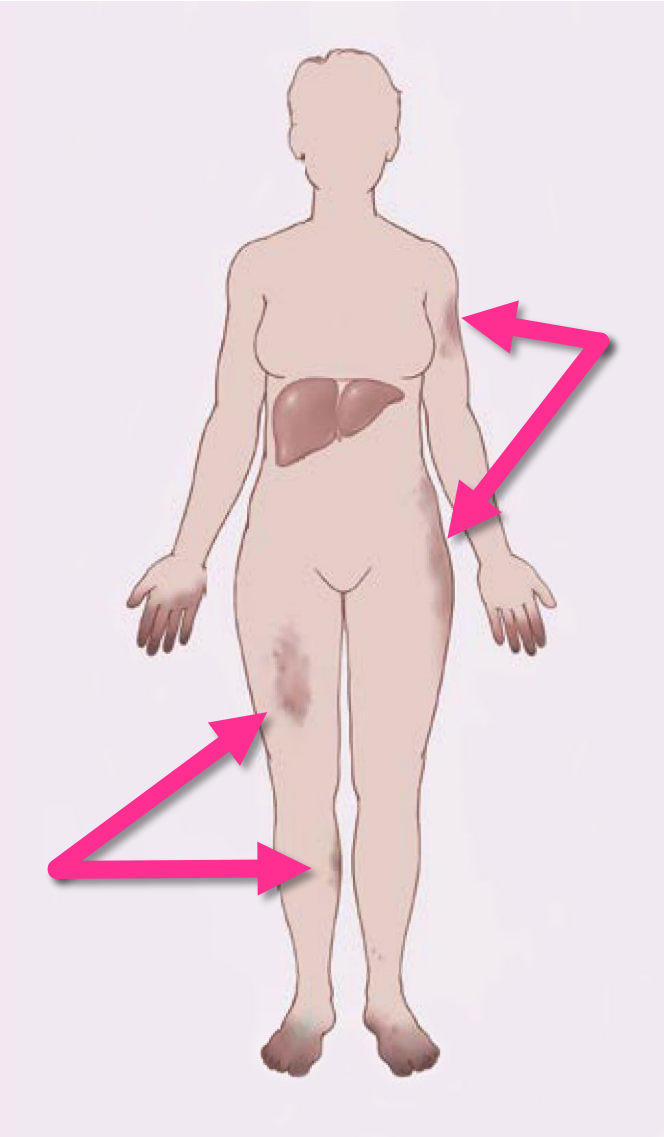
- Immunosuppression (acquired or congenital) is greatest risk for IMD

Blood vessels clot off in the extremities



LEFT → Warkentin TE. N Engl J Med. 2015 Aug 13;373(7):642-55. PMID: 26267624
RIGHT → Bendapudi PK, et al. N Engl J Med. 2021 Mar 11;384(10):953-963. PMID: 33704941

Other areas are affected in purpura fulminans



LEFT → Warkentin TE. N Engl J Med. 2015 Aug 13;373(7):642-55. PMID: 26267624
RIGHT → Bendapudi PK, et al. N Engl J Med. 2021 Mar 11;384(10):953-963. PMID: 33704941

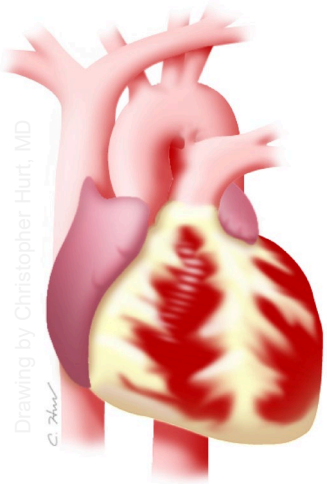
Progression of purpura fulminans

Time of admission | **Six hours later** | 48 hours after admission | Hospital day 9

Kugai T, Nakagawa H. N Engl J Med. 2017 Jun 1;376(22):2182. PMID: 28564574

Clotting is happening *inside* the body, as well

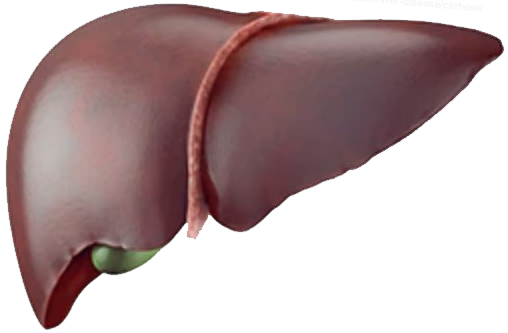
https://www.clipartkey.com/mpngs/m/23-235524_brain-png-transparent-images-3d-brain-png.png

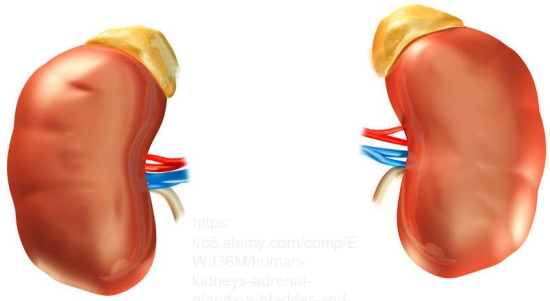


Drawing by Christopher Hurt, MD

https://img.freepik.com/free-vector/human-lungs-anatomy-structure-realistic-3d-vector-illustration-isolated-white-background-front-view-detail-right-left-lung-with-trachea-healthy-lung-respiration-system-organ_545793-913.jpg

https://www.niddk.nih.gov/health-information/liver-disease/cirrhosis





https://c8.alamy.com/comp/EWJ36M/human-kidneys-adrenal-glands-a-bladder-and-arteries-medical-3d-illustration-EWJ36M.jpg

Maintaining a high index of suspicion is **critical** for a patient's survival.

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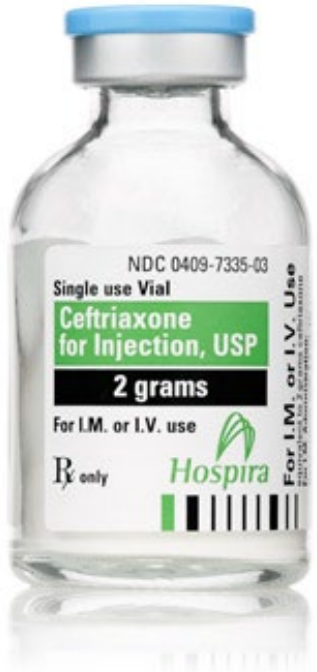
Meningococcus requires *droplet* precautions

https://www.cdc.gov/infectioncontrol/pdf/droplet-precautions-sign-P.pdf

Clinical management



IV every 12 hours

Average mortality from invasive meningococcal disease is 10-15%.

Among survivors of IMD, 20% have lost hearing and/or ≥1 limb.

https://www.meritpharm.com/product/ceftriaxone-for-injection-usp-ceftriaxone-sodium-2-gram-15-ml-injection-single-use-vial-15-ml/
https://learnenglishteens.britishcouncil.org/blogs/life-around-world/fingers-crossed

Immunization is the best protection against IMD

Table 2 Recommended Adult Immunization Schedule by Medical Condition or Other Indication, United States, 2022

Vaccine	Pregnancy	Immuno-compromised (excluding HIV infection)	HIV infection CD4 percentage and count		Asplenia, complement deficiencies	End-stage renal disease, or on hemodialysis	Heart or lung disease; alcoholism[1]	Chronic liver disease	Diabetes	Health care personnel[2]	Men who have sex with men
			<15% or <200 mm³	≥15% and ≥200 mm³							
MenACWY	1 or 2 doses depending on indication, see notes for booster recommendations										
MenB	Precaution	2 or 3 doses depending on vaccine and indication, see notes for booster recommendations									

- Recommended vaccination for adults who meet age requirement, lack documentation of vaccination, or lack evidence of past infection
- Recommended vaccination for adults with an additional risk factor or another indication
- Recommended vaccination based on shared clinical decision-making
- Precaution—vaccination might be indicated if benefit of protection outweighs risk of adverse reaction
- Contraindicated or not recommended—vaccine should not be administered.
  *Vaccinate after pregnancy.
- No recommendation/ Not applicable

- Qualifying risk factors for MenACWY and/or MenB include:
  - **Persons at increased risk during an outbreak** (e.g., community settings, **MSM**)
  - Persons who travel to or live in countries where meningococcal disease is hyperendemic or epidemic
  - Anatomically or functionally without one's spleen (e.g., advanced sickle cell disease)

ALL adults with HIV should be immunized against MenACWY (not just MSM!)

Mbaeyi SA, et al. MMWR Recomm Rep. 2020 Sep 25;69(9):1-41. PMID: 33417592; PMCID: PMC7527029
https://www.cdc.gov/vaccines/schedules/downloads/adult/adult-combined-schedule.pdf

Take-home points

- The socio-sexual networks of MSM are uniquely conducive to rapid spread of pathogens.
- Maintaining a high index of suspicion for monkeypox can help mitigate its spread.
- Recognizing the early clinical signs of meningococcal disease can save a life!
- **Be a vaccine hero!**
  Advocate for supply, facilitate access, and help educate your patients and loved ones about vaccination against monkeypox and meningococcal disease.

https://www.handshake.com/products/thanks-science-vaccine-syringe-sticker-823904

Questions?
Please email me!

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churt@med.unc.edu