Feedback from operational stakeholders who manage or respond to outbreaks is that they are often too busy to review literature or obtain relevant background information to assist them with acute response. Unlike a traditional analytical outbreak investigation report, ***Watching Briefs*** *are intended as a rapid resource for public health or other first responders in the field on topical, serious or current outbreaks, and provide a digest of relevant information including key features of an outbreak, comparison with past outbreaks and a literature review. They can be completed by responders to an outbreak, or by anyone interested in or following an outbreak using public or open source data, including news reports.*

Watching brief	
Title	Outbreak of Lumpy skin disease in India 2022 — an emerging threat to livestock & livelihoods
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Date of first report of the outbreak	2 May 2022 Gujarat- Jamnagar, India (1)
Disease or outbreak	Lumpy skin disease (LSD) outbreak
Origin (*country, city, region*)	LSD originated in Zambia in 1929 (2). The disease was endemic in many African countries for years, and has spread to other parts of the world since 1989 (2). The disease first appeared in South Asia in July 2019, when an outbreak was reported in Bangladesh (3) . In August 2019, it was identified in Odisha, West Bengal, India—which has the world's largest bovine population—and China (3).
Suspected Source (specify food source, zoonotic or human origin or other)	Lumpy skin disease is an epizootic and not a zoonotic disease. The infection is caused by the Capri pox virus - which is genetically similar to the viruses that cause goat pox and sheep pox. There is no evidence that it can affect humans (4). A major source of transmission is through ulcerated skin lesions, although the virus is shed via body secretions and excretions (including semen). Vectors such as biting flies, mosquitoes and ticks (hematophagous arthropods) transmit infection mechanically (5). Direct contact is considered ineffective as a source of infection, but may occur (6). Other potential sources of infection include consumption of contaminated milk, intrauterine transmission, dispersal through contaminated needles used for vaccination, and dispersion through

	semen of infected bulls when used for artificial insemination of cows or natural mating (6). Viral transmission from infected carcasses to naïve live animals via insects is a possible risk, but has not been sufficiently studied (6).
Date of outbreak beginning	The current outbreak in India has started on 2 May 2022. The first case was reported in Gujarat followed by Rajasthan, Punjab, Himachal Pradesh, Haryana, Maharashtra, Uttar Pradesh, Uttarakhand, Jammu Kashmir and Andaman Nicobar in the month of August 2022 (7).
Date outbreak declared over	Ongoing
Affected countries & regions	The affected regions: Sub-Saharan Africa region, North Africa, Middle east, Europe, Asia (3). The disease was endemic in many African countries since it was first identified in Zambia in 1929, and has since spread to other parts of the world. According to Food and Agriculture Organization (FAO) report, the disease first appeared in South Asia in July 2019, with Bangladesh reporting an outbreak (7). A month later, it was identified in India - which has the world's largest bovine population, in Gujarat, Rajasthan, Punjab, Himachal Pradesh, Haryana, Uttar Pradesh, Jammu Kashmir and Andaman Nicobar - and China (7).
Number of cases (specify at what date if ongoing)	As of 21 October 2022, about 2.4 million animals affected, with over 110,000 deaths (8).
Clinical features	LSD is a contagious viral disease that spreads among cattle through the bite of infected mosquitoes, flies, lice and wasps, by direct contact, and also through contaminated food and water. The incubation period ranges between 4 to 14 days post infection. The disease causes skin nodules of 2-5 cm which is the hallmark feature of LSD (9). The skin lesions can cause permanent damage to the hides (2). Some of the skin may slough away, leaving a full cavity in the skin which usually subsequently may become infected by bacteria (9). Systemic effects include pyrexia, anorexia, dysgalactia and pneumonia; lesions are often found in the mouth and upper respiratory tract. The disease causes early embryonic death, eye irritation, watery eyes, sterility, and it can be fatal. The severity of the disease varies considerably between breeds of cattle. Some individual cattle have only a few lesions; others develop severe clinical signs. Young calves and lactating cows also tend to be more severely affected (3,10).Many cattle suffer severe emaciation, lameness , keratitis, dysentery, lameness, pneumonia, mastitis and myiasis, and a drop in milk production for lasting several months (9).

Mode of transmission (dominant mode and other documented modes)	LSD is a vector-borne disease, transmitted by ticks, mosquitoes, through other blood-feeding insects; the disease causes lumps on the body of the animal and when flies and mosquitoes sit on them, they transfer the infection to other healthy animals (3). Calves can get infected from the direct contact resulting suckling of from infected cows (8).
Demographics of cases	In 2022, confirmed LSD cases were seen mostly in Northern and western states of India. Approximately 20 districts of Gujarat, 11 districts of Rajasthan, and other states such as Haryana, Himachal Pradesh, Uttar Pradesh, Uttarakhand and Andaman Nicobar were affected. It tends to be more common in warm, humid areas, but is not limited to these regions. Rajasthan is the most affected state. The number of cases typically increases during wet, warm weather (monsoons), when more vectors are present, and decreases during the dry season. New foci of disease can appear at distant sites, which may be due to be cause of legal or illegal transfer of cattle between farms, regions or even countries (6). The movements of cattle may allow the virus to travel over long distances (6). Shorter-distance transmission leaps, equivalent to how far insects can fly (usually < 50 km), are caused by numerous local blood-feeding insect vectors feeding on cattle and changing hosts frequently between feeds (6). Lumpy skin disease may affect only a few cattle in a herd, although other animals can be sub clinically infected. Some individual cattle have only a few lesions; others develop severe clinical signs. Young calves and lactating cows tend to be more severely affected (6,10). Exotic and mixed breeds seems to be more susceptible than indigenous breeds (11,12).
Case fatality rate	Reported LSD morbidity rates in the affected states of India during the ongoing 2022 outbreaks range from 5 to 45% (13), while mortality rates in the affected states of India are often between 1% and 5%, but are occasionally higher or lower (13). The wide range of morbidity may be due to presence of a greater number of stray cattle in some states. Reported morbidity and mortality rates in unvaccinated cattle are higher compared to vaccinated cattle (13). Case fatality rates ranged from 2-10% (7). The states are reporting more mortality in stray animals, especially in Gujarat and Rajasthan. There are about 5 million stray cattle in the country, out of which 4 million are in the nine affected states, according to the Livestock Census 2019. Stray cattle are weaker and have low immunity in general (14). Therefore, more deaths are being reported, especially from drought-prone regions in Gujarat and Rajasthan (14).

Complications	Pneumonia caused by the virus itself or secondary bacterial infections, and mastitis are common complications (1, 5,12). Secondary bacterial infections can cause permanent damage to the tendons, joints, teats and mammary gland (5,12). Temporary or permanent sterility is possible in bulls, and pregnant cows may abort (1,5,12). Some aborted foetuses and premature calves have been covered in nodules; no nodules were found in other cases (5,12). Most animals with lumpy skin disease slowly recover, although severely affected animals may die (1,5,12). Recovery can take several months, and some skin lesions may take a year or two to resolve. Deep holes or scars are often left in the skin (10).
Available prevention	In India, goat pox vaccine is the current management strategy which gives 60 to 70 % protection against Lumpy skin disease without any side effects (8,15,16). The vaccine takes 15-20 days to become effective (3). The population of cattle in India is around 200 million, and already 15 million doses have been administered (14). Ring vaccination was done as priority in the 5-kilometre radius of the outbreak, especially in border areas of different states with the aim to limit spread to neighbouring states (17). The vaccine was provided free of cost by the state governments. The Union Ministry for Fisheries, Animal Husbandry and Dairying has contacted the vaccine manufacturers to enhance the production to meet the ongoing requirements. The Indian Council for Agriculture Research-National Research Centre on Equines (ICAR-NRCE), Hisar (Haryana), in collaboration with ICAR-Indian Veterinary Research Institute (IVRI), Uttar Pradesh has developed an indigenous vaccine for LSD called Lumpi-ProVacInd vaccine. For the Lumpi-ProVacInd which is a homologous vaccine, efficacy is claimed to be 100 % by the ICAR scientists (16). The estimated cost per dose for the vaccine is ₹1-2. The government of India has assured the commercial production and roll out of the vaccine at the earliest (18,19). Other prevention measures include movement control of bovine animals and quarantining, implementing biosecurity measures, vector control by sanitising sheds and spraying insecticides, and mass awareness campaigns (2,15).
Available treatment	There is no specific treatment for LSD, however, supportive care, including antibiotics as necessary for secondary bacterial infections, can be helpful. Wound dressings have been used to reduce fly strike and secondary infections (10).

Comparison with past outbreaks	The geographical spread of the LSD was mainly in Odisha during 2019 outbreak. However, in the current 2022 outbreak, Gujarat and at least 15 other states have reported cases (9). In the 2022 outbreak, the virus has been found to evolve within a single host, and infectivity of virus appears to have increased when compared with the 2019 outbreak. Analysis of the viral sequence suggest the genomes from the 2022 outbreak harbour a large number of genetic variations compared to the reference genome, and form a distinct lineage (19). The analysis of the genomes revealed 177 unique variants, none of which were found in four genome sequences from India belonging to the 2019 outbreak of the disease (20). During the 2019 outbreak, the morbidity rate was 7.1 %, with no mortality (21). The increased morbidity and mortality during the current outbreak may be attributed to evolution of new variants.
Unusual features	In the 2022 outbreak, the following unusual features were identified: 1. Geographical spread is larger when compared to previous outbreaks. 2. Genomic characteristics of strains isolated from Indian cattle are not similar to those found in endemic countries. Different subtypes of virus were isolated in samples taken from different body sites of the same animal.
Critical analysis	The long porous borders between India, Nepal and Bangladesh allow for a significant amount of bilateral and informal animal trade, including cattle and buffaloes. This may have contributed to the spread of LSD in July-August 2019 between Bangladesh and India. While the 2019 outbreak later subsided around December 2019 (1), the recent spread in India began in May his year (8). Misinformation about the origin of the LSD is circulating on social media. This includes the false claim that LSD has entered India from Pakistan, and that it is part of a Pakistani conspiracy against India's cows. Cows are considered sacred by India's majority Hindu population. From the official reports of Indian Veterinary Research Institute, the disease entered India from Bangladesh — not from Pakistan — due to natural animal movement and transport at the border. Cases in Bangladesh were reported earlier than cases in India. In Pakistan, cases were reported later, after being reported in India (8). Many viral social media posts falsely claim that milk has become unsafe for human consumption due to the spread of LSD, and that drinking milk from an infected animal will lead to the development of a skin disease in humans as well. The posts are often accompanied by images of visibly diseased human bodies covered in lesions, designed to create fear. Dairy farmers are suffering due to the false claim. Searches for "can we

	drink milk of lumpy skin disease cow" grew by more than 5,000% between 21 September and 21 October 2022 (30 day period) according to data from Google Trends (8). Misinformation has made people wary of consuming milk. Dairy farmers who are already under economic stress after losing cattle to LSD are now facing the added burden of stigma from people who refuse to buy milk. A cattle vaccination programme is currently underway in several states across India, using the goat pox vaccine due to provision of cross protection against LSD. Indian researchers have also developed a vaccine against LSD, which is yet to become commercially available. Misinformation about LSD has been compounded with anti-vaccine conspiracies on social media. False claims such as that cattle are dying after being administered the vaccine are spreading in the social media, which in turn adversely impacts the vaccination campaign. Vaccination rates vary widely among the states of India. Uttar Pradesh has completed vaccination of almost 100% cows in seven districts and more than 80% in 22 districts as per state government reports. However, there are districts with zero vaccination, such as in Rajasthan, where there is widespread shortage of vaccines for LSD. Scientists say that the country requires about 200 million doses of vaccine and that vaccination should be accelerated (16). The government has initially granted permission for the goat pox vaccine to be administered to the cattle as protection against LSD, with only two manufacturers in the country (16). Similarly effective sheep pox vaccine, which has about a dozen manufacturers, has not been allowed (16). Granting permission for the sheep pox vaccine may accelerate the vaccination process to protect the cattle against LSD through better vaccine availability (16). The LSD virus may have already mutated in India. The College of Veterinary Science Animal Husbandry, Jabalpur, is studying gene sequences of the samples collected from infected cattle in Madhya Pradesh, and has found that the strain is different from the one isolated in Odisha during the first outbreak (2). We have identified the following reasons for the proliferation of the current outbreak in India, 1. Long porous borders with neighbouring countries which have LSD outbreaks 2. Misinformation in the media resulting, shifting attention away from proper preventive measures 3. Mutation of virus making it more infectious 4. Shortage of vaccines affecting the preventive measures.

Key questions	• What is the most effective way to address shortage of vaccines? • How important is the surveillance and characterisation of circulating strains of LSD? • What is the need to continually refine the strategies for differentiating vaccine strains from field viruses? • What is the most effective way to handle and address flying rumours and misinformation? • What is the most effective way to ensure safe disposal of carcasses of dead animals? • What is the most effective way to address economic implications to dairy farmers?
Acknowledgements	This Watching Brief is an output of an epidemiology workshop between The National Institute of Epidemiology and EPIWATCH.
References	1. Jolly B, Scaria V. The evolution of lumpy skin disease virus. The Hindu [Internet]. 2022 Sep 24 [cited 2022 Oct 27]; Available from: https://www.thehindu.com/sci-tech/the-evolution-of-lumpy-skin-disease-virus/article65928113.ece 2. Munjal D. Explained | What is lumpy skin disease in cattle? Does it affect milk we consume? The Hindu [Internet]. 2022 Sep 20 [cited 2022 Oct 27]; Available from: https://www.thehindu.com/news/national/explained-what-is-the-lumpy-skin-disease-affecting-cattle-in-india-what-are-its-economic-implications-and-does-it-affect-milk-for-consumption/article65911590.ece 3. Chhara RG & Patel S. Lumpy skin disease: Cattle farmers in Gujarat, Rajasthan reel under outbreak - BBC News [Internet]. [cited 2022 Oct 27]. Available from: https://www.bbc.com/news/world-asia-india-62474457 4. Bondre V. Lumpy Skin Disease in livestock poses no risk to human health [Internet]. The Indian Express. 2022 [cited 2022 Oct 27]. Available from: https://indianexpress.com/article/cities/pune/lumpy-skin-disease-in-livestock-poses-no-risk-to-human-health-8149565/ 5. Jena BR, Kantale RA, Dash A, Singh P, Basak G, Singh S, Jadhao A. Emergence of lumpy skin disease virus (LSDV) infection in cattle and buffaloes in India, The Pharma Innovation Journal. 2022, 11(11):1857-1861 6. Tuppurainen E, Alexandrov T, Beltrán-Alcrudo DJ. Lumpy skin disease-a manual for veterinarians. FAO Animal Production and Health Manual. 2017(20) 7. Konda H. No case of lumpy skin disease in humans is reported in India since it's outbreak [Internet]. FACTLY. 2022 [cited 2022 Oct 27]. Available from: https://factly.in/no-case-of-lumpy-skin-disease-in-humans-is-reported-in-india-since-its-outbreak/

8. Arora M. Lumpy skin disease: Viral cattle disease sends rumours flying in India - BBC News [Internet]. [cited 2022 Oct 27]. Available from: https://www.bbc.com/news/world-asia-india-63262411

9. Malabadi RB, Kolkar KP, Chalannavar RK. Outbreak of Lumpy Skin Viral Disease of cattle and buffalo in India in 2022, Ethnoveterinary Medicine Approach, 2022, 04(11): 3562-3574

10. Spickler AR. Lumpy skin disease. Iowa, USA: Center for Food Security and Public Health (CFSPH), Iowa State University

11. World Organization for Animal Health. Lumpy Skin Disease [Internet]. [cited 2023 Jan 8]. Available from: https://www.woah.org/app/uploads/2021/03/lumpy-skin-disease.pdf

12. Singh R. Epidemiology of Lumpy Skin Disease in India – Pashudhan praharee [Internet]. 2022 [cited 2023 Jan 8]. Available from: https://www.pashudhanpraharee.com/epidemiology-of-lumpy-skin-disease-in-india/

13. Sharma H. Lumpy skin disease: Nearly 1 lakh cattle deaths, toll almost double in three weeks | India News,The Indian Express [Internet]. [cited 2023 Jan 8]. Available from: https://indianexpress.com/article/india/lumpy-skin-disease-punjab-haryana-hp-together-see-over-25000-deaths-8172890/lite/

14. Livemint. Lumpy skin disease has killed over 67,000 cattle's so far: Centre [Internet]. mint. 2022 [cited 2022 Oct 27]. Available from: https://www.livemint.com/news/india/lumpy-skin-disease-has-killed-over-67-000-cattle-s-so-far-centre-11662987782320.html

15. Government of India. Department of Animal Husbandry & Dairying Guidelines for prevention of LSD (Lumpy skin disease) [Internet]. [cited 2023 Jan 9]. Available from: https://megahvt.gov.in/notification/Lumpy_Skin_Disease_Advisory.pdf

16. Singh H. Vaccination against Lumpy Skin Disease at sluggish pace as only goat pox vaccine allowed [Internet]. Ruralvoice. 2022 [cited 2023 Jan 9]. Available from: https://eng.ruralvoice.in/national-23/vaccination-against-lumpy-skin-disease-at-sluggish-pace-as-only-goat-pox-vaccine-allowed.html

17. Shagun. Lumpy disease: 35,000 cattle killed in 9 states [Internet]. [cited 2022 Oct 27]. Available from: https://www.downtoearth.org.in/news/wildlife-biodiversity/lumpy-disease-35-000-cattle-killed-in-9-states-84540

18. Abdul. Big relief for livestock, Agriculture Minister launches indigenous vaccine for Lumpy Skin disease [Internet]. Forum IAS Blog. 2022 [cited 2022 Oct 27]. Available from: https://blog.forumias.com/big-relief-for-

livestock-agriculture-minister-launches-indigenous-vaccine-for-lumpy-skin-disease/

19. Bhatt L, Bhoyar RC, Jolly B, Israni R, Vignesh H, Scaria V, et al. The genome sequence of the Lumpy Skin Disease virus from the outbreak in India suggests a distinct lineage of the virus. bioRxiv. 2022 Jan 1;2022.09.15.508131

20. Koshy J. Lumpy skin disease virus different from 2019 version. The Hindu [Internet]. 2022 Sep 18 [cited 2022 Oct 27]; Available from: https://www.thehindu.com/news/national/lumpy-skin-disease-virus-different-from-2019-version/article65906807.ece

21. Sudhakar SB, Mishra N, Kalaiyarasu S, Jhade SK, Hemadri D, Sood R, et al. Lumpy skin disease (LSD) outbreaks in cattle in Odisha state, India in August 2019: Epidemiological features and molecular studies. Transboundary and Emerging Diseases. 2020 Nov;67(6):2408–22