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Disease surveillance during a large religious mass gathering in India: The Prayagraj Kumbh 2019 experience



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ABSTRACT

Background: Mass gathering (MG) events are associated with public health risks. During the period January 14 to March 4, 2019, Kumbh Mela in Prayagraj, India was attended by an estimated 120 million visitors. An onsite disease surveillance was established to identify and respond to disease outbreaks. **Methods:** A health coordination committee was established for planning. Disease surveillance was prioritized and risk assessment was done to identify diseases/conditions based on epidemic potential, severity of illness, and reporting requirement under the International Health Regulations (IHR) of 2005. A daily indicator and event-based disease surveillance was planned. The indicator-based surveillance (IBS) manually and electronically recorded data from patient hospital visits and collected MG area water testing data to assess trends. The event-based surveillance (EBS) helped identify outbreak signals based on pre-identified event triggers from the media, private health facilities, and the food safety department. Epidemic intelligence was used to analyse the data and events to detect signals, verify alerts, and initiate the response.

Results: At Kumbh Mela, disease surveillance was established for 22 acute diseases/syndromes. Sixty-five health facilities reported 156 154 illnesses (21% of a total 738 526 hospital encounters). Among the reported illnesses, 95% ($n = 148\,834$) were communicable diseases such as acute respiratory illness ($n = 52\,504$, 5%), acute fever ($n = 41\,957$, 28%), and skin infections ($n = 27\,094$, 18%). The remaining 5% ($n = 7300$) were non-communicable diseases (injuries $n = 6601$, 90%; hypothermia $n = 224$, 3%; burns $n = 210$, 3%). Water samples tested inadequate for residual chlorine in 20% of samples (102/521). The incident command centre generated 12 early warning signals from IBS and EBS: acute diarrheal disease ($n = 8$, 66%), vector-borne disease ($n = 2$, 16%), vaccine-preventable disease ($n = 1$, 8%), and thermal event ($n = 1$, 8%). There were two outbreaks (acute gastroenteritis and chickenpox) that were investigated and controlled.

Conclusions: This onsite disease surveillance imparted a public health legacy by successfully implementing an epidemic intelligence enabled system for early disease detection and response to

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monitor public health risks. Acute respiratory illnesses emerged as a leading cause of morbidity among visitors. Future MG events should include disease surveillance as part of planning and augment capacity for acute respiratory illness diagnosis and management.

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Introduction

Mass gatherings (MG) for religious events are a source of religious and cultural tourism within the country of origin and abroad. They involve an influx of a large number of people to a fixed site for a specific duration. The increase in crowd density can have health implications for communicable disease transmission due to the increase in intermixing of healthy and diseased populations and exposure to microbes; this also places a strain on the existing medical care and water and sanitation services, as well as entailing an increased threat of mass casualties due to stampede and terrorism (Memish et al., 2019).

India accounts for the largest number of religious MG events in the world. Nine of 23 pilgrimage places in the world that record more than half a million visitors annually are in India (Anon, a). The Kumbh Mela is an ancient Hindu religious riverside pilgrimage held for 3 months, usually at a fixed astrological time. The Kumbh Mela venue rotates between Prayagraj on the banks of the Ganga, Yamuna, and mythical Saraswati, Nasik on the banks of the Godavari River, Ujjain on the Shipra River, and Haridwar on the Ganga River. Bathing in these rivers during the Kumbh Mela is considered an endeavour to cleanse both body and spirit (Rana Singh, 2013; Dubey, 2001). The Kumbh Mela of Prayagraj is said to be particularly auspicious, as it is held at the sangam, which is the confluence of three sacred rivers: Ganga, Yamuna, and mythical Saraswati (Rana Singh, 2013).

The Prayagraj Kumbh Mela of 2013 drew a crowd of approximately 100 million pilgrims (Vortmann et al., 2015; David and Roy, 2016); in 2019, it attracted nearly 120 million, of which approximately one million visitors were from abroad (Parliament of India Lok Sabha House of the People, 2020). An influx of a large number of people at MG events poses a significant public health risk to visitors and the local population, and places strains on the health systems. It can also threaten global health security due to the potential for rapid spread of high-consequence pathogens following inadequate preparedness. When hosting such large MGs, authorities are required to do advanced planning and infrastructure creation for water, sanitation, hygiene, and medical care. Public health surveillance and response capacity are critical at such MG events for managing public health threats. The state and national government have recognized the potential public health risks of this enormous influx of people over the 3-month pilgrimage period. Six holy bathing days during this period are considered very auspicious to take a dip in the river. There is a surge in the number of floating pilgrims congregating on these days. This article describes the public health preparedness and implementation of an onsite disease surveillance during the Prayagraj Kumbh mass gathering of 2019 in Uttar Pradesh Province of India.

Methods

Management and coordination mechanism, public health preparedness

Uttar Pradesh is one of the largest and most populous provinces of India (Anon, c). For the Prayagraj Kumbh Mela 2019, the Uttar Pradesh (UP) provincial government enacted an authority (known as UP Prayagraj Mela Authority, Allahabad Act, 2017) (UP Prayagraj

Mela Authority, Allahabad, Act, 2018). A health coordination committee was identified for planning and management of health-related issues at the Kumbh Mela MG. The stakeholders included the Uttar Pradesh Health Department, National Centre for Disease Control (NCDC), Integrated Disease Surveillance Programme (IDSP), National Vector Borne Disease Control Programme (NVBDCP), Food Safety and Standards Authority (FSSAI), International Health Division of Directorate General of Health Services, National Disaster Management Authority (NDMA), and partners including the US Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) India country offices.

Surveillance

Risk assessment and prioritizing disease surveillance

An expert group constituted by the coordination committee conducted an all-hazard risk assessment. It reviewed the existing IDSP disease surveillance in the town of Prayagraj, with weekly clinical and laboratory reporting from public health facilities. Based on risk assessment, they planned to augment the weekly passive surveillance with an onsite daily MG surveillance to capture patient visits to health facilities that were established to cater to the inflow of visitors during Kumbh Mela. They identified diseases/syndromes based on epidemic potential, the severity of illness, and the requirement for reporting under the International Health Regulations (IHR) of 2005.

Establishing disease surveillance

An onsite surveillance system was established for the MG site, comprising a structured integrated daily indicator-based surveillance (IBS) and event-based surveillance (EBS), in addition to the existing IDSP system for the town of Prayagraj (Figure 1) (Paquet et al., 2006).

IBS was planned to manually and electronically record patient health facility (reporting unit) encounters for diseases under surveillance, mortality, and water quality monitoring reports. EBS helped identify health-related events based on pre-identified event triggers from the media, private health facilities, and the food safety department. These were assessed for any public health threat likely to jeopardize the MG. Once the framework for the surveillance system was developed, a cascade training plan was designed for the surveillance staff. The plan included training of trainers involved in disease surveillance and a series of training sessions for medical officers, pharmacists, and laboratory technicians in reporting units. The training focused on the correct identification of conditions under surveillance, data recording, and data transmission.

A laboratory network assessment of local, regional, and national laboratories was done. Designated laboratories were identified for carrying out specialized testing. Rapid test kits were made available at the health facilities (reporting units) within the Kumbh Mela site for a few of the disease conditions under surveillance. Training for sample collection and transportation was given to laboratory technicians posted at the MG.

Epidemic intelligence and rapid response

An incident command centre (ICC) was created with trained human resources to analyse data and events on a daily basis from

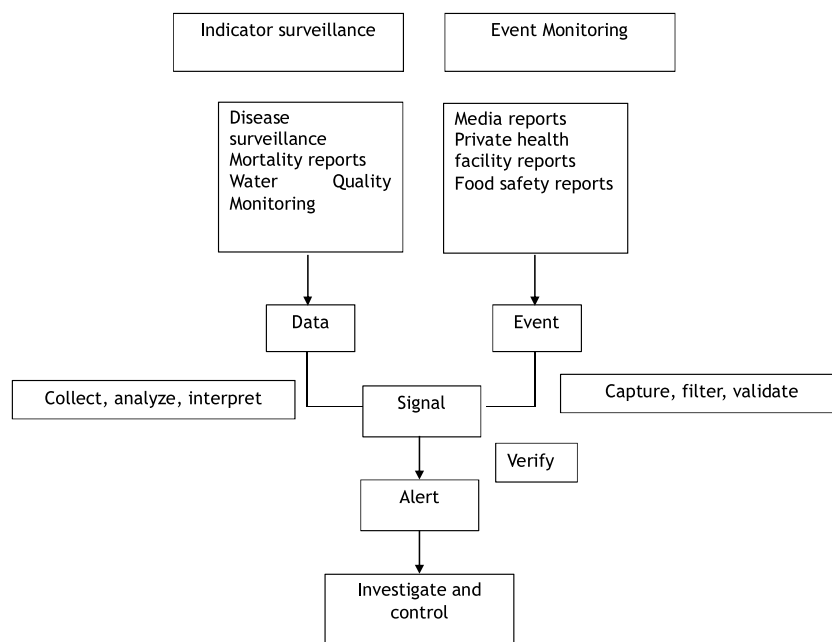


Figure 1. Surveillance flowchart at Prayagraj Kumbh, January to March 2019.

IBS and EBS to detect signals, verify alerts, and initiate the response. A system of cross-notification for infectious disease cases leaving for home states from the MG site were generated through the IDSP system. The NCDC deployed Epidemic Intelligence Service (EIS) officers to support disease surveillance activities. The surveillance team also conducted daily monitoring of reporting units to ensure the quality and timeliness of reporting. Onsite training on case definitions, reporting channels, and health system gaps were identified for correction.

Results

Management and coordination mechanism, public health preparedness

Under the provisions of the UP Prayagraj Mela Authority, Allahabad Act, 2017, a temporary tent city was created on the river bed at the confluence of the Ganga and Yamuna rivers. This area spread over 42 square kilometres and was divided into 20 sectors on both sides of the river, connected by pontoon bridges. The tent city was notified as a district and the Mela authority was empowered to provide for civic facilities, security, health care, infection prevention, disease surveillance, and disaster management at the MG venue. The health coordination committee supported the Mela authority in planning for public health-related issues and prioritizing disease surveillance at the MG venue.

Each sector had an independent sanitary and 20-bed indoor health unit. Additionally, 30 first aid health stations were set up at vulnerable locations (sites where crowding was expected on six major bathing/holy days). The pilgrims attending the MG were of two types: (1) semi-permanent residents (comprising sages and pilgrims following different Hindu sects known as akhara sadhus and kalpawasis) who reside at the MG site for a period of 3 months, and (2) floating pilgrims who come for a short period of 2–3 days to take a holy dip in the river. There were two sectors designated for semi-permanent residents. These areas were targeted for vector control measures. Information, education, and communication

(IEC) display messages were targeted at pilgrims to consume safe food. Food safety officers were identified to randomly monitor food quality and food safety norms at community kitchens and food vendor premises. Five thousand public taps were set up to provide safe drinking water and handwashing facilities, and 100 000 sanitary toilets were created at the MG site.

There was one 100-bed indoor hospital, which served as a referral unit. Six babies were also delivered during the MG in this referral unit. More than 3000 medical and paramedical staff deployed at these onsite health facilities were trained in disease surveillance in 356 sensitization sessions.

Surveillance

Risk assessment, prioritizing and establishing disease surveillance

Onsite disease surveillance was established for 22 acute diseases/syndromes using standardized case definitions (Appendix 1). Sixty-five onsite health facilities were established as reporting units (RUs). Daily reports were received from reporting units in five surveillance zones by 11 a.m. Figure 2 shows the data flow and feedback from RUs to the ICC and relevant stakeholders. From January 14 to March 3, 2019, a total of 738 526 (<1% inpatient) health care visits were identified. There were eight deaths reported, two of which were related to disease conditions under surveillance (hypothermia). Of the total hospital encounters, 17% (128 470/738 526) were during five auspicious bathing days (Figure 3). The largest number of health care visits (7%, 54 667/736 526) was seen on the day of Mauni Amavasya (bathing day). Forty-one percent of cases were reported from surveillance zone 1.

Surveillance findings

The surveillance system identified 156 154 reportable conditions; 148 834 (95%) were communicable diseases and 7300 (5%) were non-communicable diseases. Among the communicable diseases, acute respiratory illness (ARI) ($n = 52\,504$, 35%), acute fever ($n = 41\,957$, 28%), and skin infections ($n = 27\,094$, 18%) were the most frequently reported (Figure 4). Regarding the

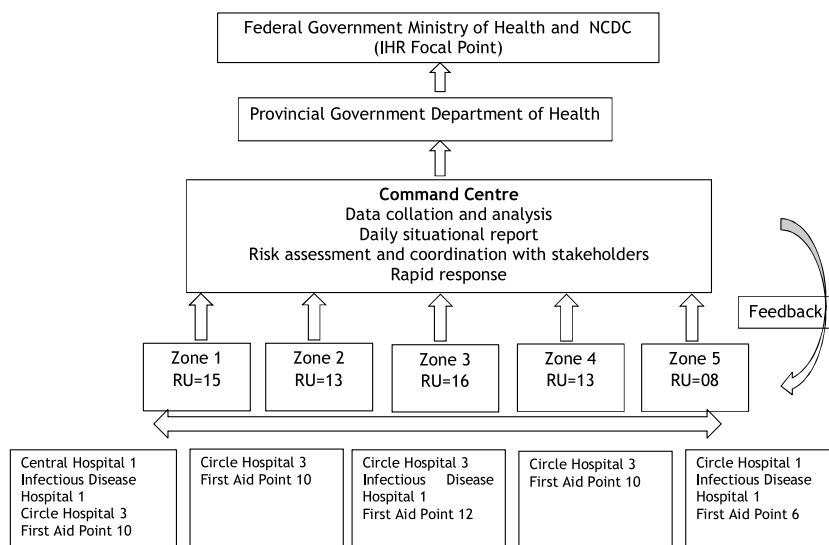


Figure 2. Surveillance data flow in Prayagraj Kumbh, January to March 2019.

non-communicable diseases, minor injury ($n = 6601$, 90%), hypothermia ($n = 224$, 3%), and burns ($n = 210$, 3%) were the most frequently reported (Figure 5).

In the time frame under surveillance, the trend of ARI cases/100 out-patient cases showed a peak in proportionate morbidity in the first week of February 2019 and then decreased to the baseline level. This rise coincided with the time of the main bathing days (Figure 6). Of 521 water samples tested, 102 (19.5%) had inadequate residual chlorine levels. In 14.5% (7/48) of water samples, an indication of bacterial contamination was found.

Epidemic intelligence and rapid response

The ICC generated 12 early warning signals from indicator and event surveillance. Of these, 66% (8/12) were for acute diarrhoeal diseases, 8% (1/12) for thermal event, 16% (2/12) for vector-borne diseases, and 8% (1/12) for vaccine-preventable disease. Two outbreaks were identified. One chickenpox outbreak was reported amongst students of a Vidyapeeth (religious sect school) residing in ward 4 of Kumbh Mela area. All cases were male, with an age range of 12–19 years (median age 18 years), and the attack rate was

40% (14/35). The outbreak was contained after active cases were identified and admitted to the isolation ward of an infectious disease hospital. Overcrowding in the tents was found to be a risk factor for the outbreak. One foodborne illness outbreak was reported among sanitation workers in ward 5 of Kumbh Mela area (attack rate 7.6%, 16/210; median age 25 years; hospitalization rate 50%, 8/16). A case-control study identified eating semolina porridge made of leftover boiled potatoes as the risk factor for illness. The rapid response (within 2 h) and investigation was facilitated by frequent FSSAI inspections and strict compliance with food safety guidelines in community kitchens at the MG site. The NCDC, which is also the WHO IHR focal point for India, reviewed daily situational assessment reports. No international health alerts were issued related to Prayagraj Kumbh.

Discussion

This article describes the public health preparedness and implementation of an onsite integrated indicator and event-based disease surveillance system for the Prayagraj Kumbh MG event in

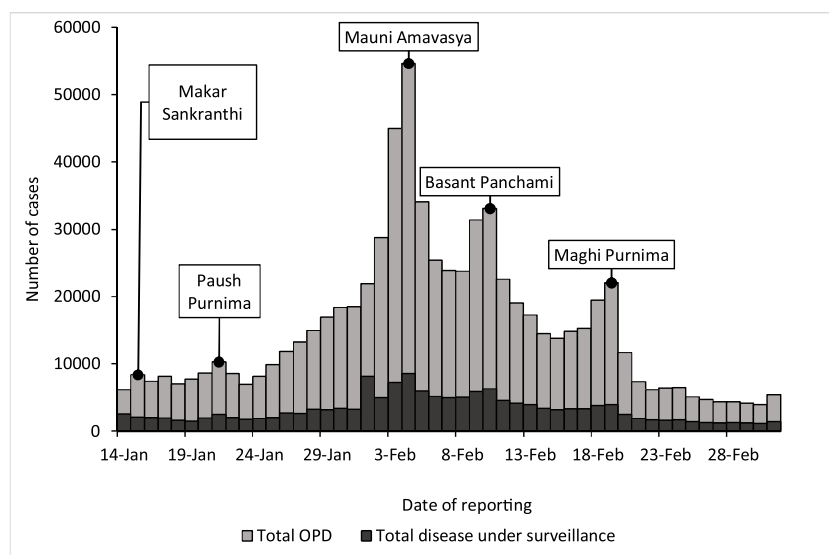


Figure 3. Time distribution of total hospital encounters ($n = 738\ 526$) and health conditions under surveillance ($n = 156\ 154$) from January 14 to March 3, 2019.

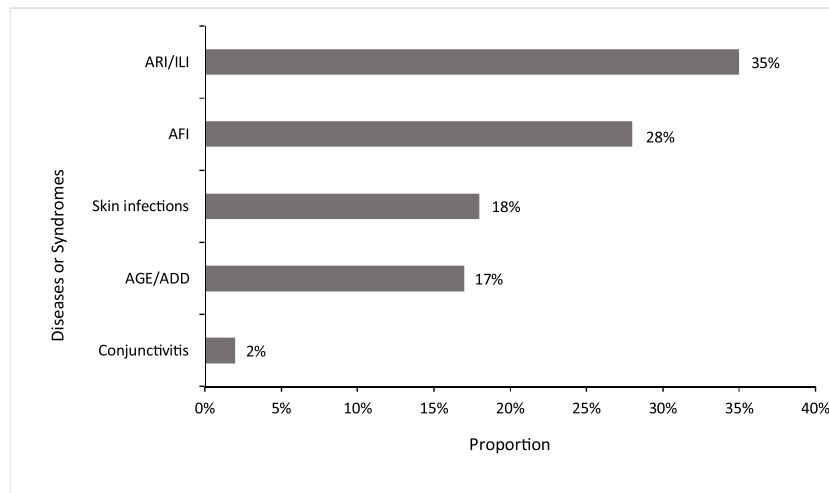


Figure 4. Proportions of major communicable diseases from January 14 to March 3, 2019, Prayagraj Kumbh 2019 (n = 148 834).

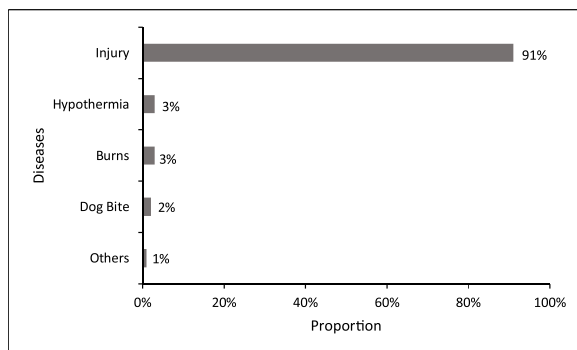


Figure 5. Proportions of major non-communicable diseases from January 14 to March 3, 2019, Prayagraj Kumbh 2019 (n = 7300).

India. Multiple stakeholders were involved in this comprehensive response. The real-time surveillance resulted in almost 740 000 cumulative events reported. Twelve early warning signals were identified. Two outbreaks (i.e., gastroenteritis and varicella) were confirmed and investigated, and interventions were implemented to prevent additional morbidity and mortality. No major outbreaks likely to threaten the MG event were detected. Surveillance data

were useful for public health action with early detection and response.

A gathering of this magnitude can be an administrative and logistical challenge. To plan and manage the MG event, the UP provincial government established a Kumbh Mela authority with the unified command, coordination, and communication channel. A health coordination committee led by the UP provincial health department with various stakeholders was established. The committee provided strategic oversight and undertook advanced planning activities to set up water, sanitation, disaster management, health care, infectious disease prevention, and disease surveillance activities. Several important lessons were learned regarding the effective implementation of an onsite disease surveillance system. These are discussed below.

Given the scale of this MG event, its cultural importance, and the consequences of any adverse event on national and global health security, the government along with partners planned to invest in a special surveillance based on the WHO risk assessment criteria (World Health Organization, 2012). Disease surveillance was incorporated into early planning, along with health care and sanitation. Although such drop-in systems are resource-intensive (World Health Organization, 2020), enhancement of the existing IDSP system alone was likely to miss patient encounters at onsite

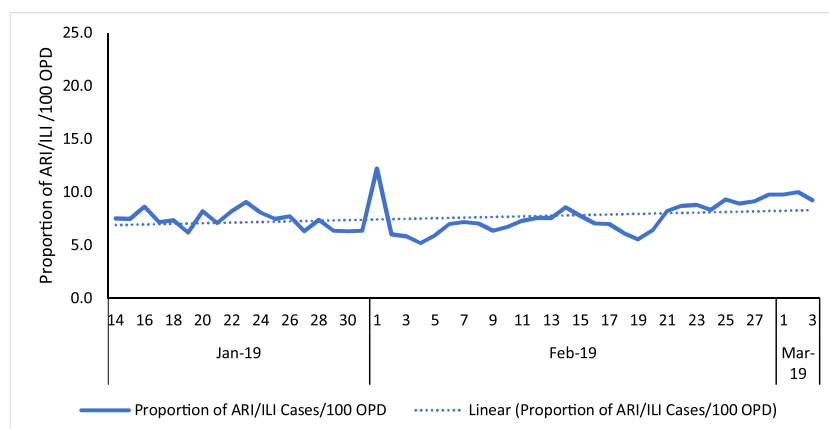


Figure 6. Trend in acute respiratory illness (ARI)/influenza-like illness (ILI) cases during the surveillance period from January 14 to March 3, 2019, Prayagraj Kumbh 2019 (n = 52 504).

health facilities that were established to cater to the inflow of visitors at the Prayagraj Kumbh site.

An ICC run by designated officers facilitated the coordination of resources and operational information from surveillance reports with pre-identified response stakeholders. This model enabled quick and efficient decision-making for public health action. Water quality and food quality surveillance reports were linked with acute diarrhoeal disease cases. Similarly, vector control activities were intensified based on vector-borne disease reporting.

This MG special surveillance identified acute respiratory infections as a leading cause of morbidity among the visitors. A probable chickenpox outbreak was also identified, which also spreads through the respiratory route. Respiratory tract infections are commonly reported during Hajj, known as the pilgrim's cough (Memish et al., 2014). This calls for strengthening of diagnosis for high consequence respiratory pathogens such as influenza virus, Middle East respiratory syndrome coronavirus, and other coronaviruses in a MG setup, along with the opportunity for vaccination of vulnerable groups. India has one of the largest burdens of tuberculosis (TB) and multidrug-resistant TB (MDR-TB) in the world (RNTCP National Strategic Plan for Tuberculosis Elimination, 2017–25). The government of India has set a goal of TB elimination by 2025 (RNTCP National Strategic Plan for Tuberculosis Elimination, 2017–25). Large MG events such as Kumbh serve as an opportunity for TB screening among patients with respiratory symptoms (productive cough over 2–3 weeks). The availability of sensitive and rapid molecular point-of-care tests such as the Xpert MTB/RIF assay make them suitable for use in such settings (Zumla et al., 2016). These TB screening programmes could be linked to treatment in those detected with active disease.

The daily disease surveillance identified a probable chickenpox outbreak and an acute gastroenteritis outbreak, but laboratory confirmation could not be done due to limited laboratory capacity. All of the cases were managed on a presumptive basis. For future MG events, laboratory capacity needs to be strengthened to ensure timely and accurate diagnosis of outbreak-prone diseases and high consequence emerging pathogens. Rapid diagnostic test kits could be used to facilitate early laboratory confirmation to prevent the spread of diseases.

MG events serve to potentially amplify the risk of spread of emerging respiratory infections such as COVID-19. Many high-profile religious and sporting MG events have been cancelled in 2020 (McCloskey et al., 2020). It is imperative that future organizers undertake risk assessment for COVID-19 while planning and implementing a MG during the COVID-19 pandemic (McCloskey et al., 2020). This should be performed together with augmenting disease surveillance and management capacity for severe respiratory illnesses.

Health system capacity to receive and analyse surveillance data for public health action underpins public health readiness for MG events (Fleischauer and Gaines, 2017; Schenkel et al., 2006; World Health Organization, 2005). The lack of specific training programmes and a shortage of skilled public health personnel are some of the challenges faced by developing countries to address public health issues during MG (Alnour and Fleischauer, 2013). During the preparatory phase, state health department officials were trained in key epidemiological capacities supported by India EIS officers of the NCDC. The government of India runs the India EIS training programme, a 2-year advanced field epidemiology training that develops core competencies in disease surveillance and outbreak investigation (Compendium of India Epidemic Intelligence Service (EIS) Programme, 2020). Trained rapid response teams were mobilized early if an outbreak was detected. These training programmes for local health staff in preparation for the MG event led to short-term improvements in the capacity to identify, notify, and respond to public health threats. Similar

short-term improvements have been reported from other enhanced MG syndromic surveillance (Schenkel et al., 2006; Elliot et al., 2013). This also provides an opportunity to assess longer-term sustainable surveillance improvements.

Continuous and concurrent monitoring of surveillance activities also led to unintended public health benefits including the availability of data on the OPD [Au?3] load for planning health care workforce deployment, as well as drug and vaccine supply in sector hospitals. For reporting, data entry and collation were done using both paper-based and tablet application-based media. As this was the first time a tablet application-based system was used for MG disease surveillance data collection on this scale, initial challenges were faced in getting electronic data from all reporting units. Extensive hand-holding training and incentives to data entry operators were measures adopted to encourage reporting. Lack of familiarity with the user interface often led to data entry errors. The paper-based system was also continued as a backup for data verification for the entire surveillance period. Despite initial challenges, the collection of data in a Web portal ensured faster data analysis and interpretation. There are reports of the successful use of digital technologies used for surveillance linked to a command and control centre in MG events (Memish et al., 2014; Nsoesie et al., 2015).

This MG surveillance system had a few limitations. The number of pilgrims attending the MG event fluctuated throughout the surveillance period. During the five bathing days, the proportion of attendees rose several-fold. This, combined with the non-availability of previous baseline data, did not provide scope for the generation of outbreak thresholds from surveillance data. This is a well identified limitation associated with syndromic surveillance implemented for MGs in other parts of the world (World Health Organization, 2020; Nsoesie et al., 2015). In the context of fixed periodic MG events in the Indian subcontinent such as Kumbh, the development of a minimum dataset requirement for MG surveillance with standard case definitions will make surveillance data comparable across events and locations. The surveillance system did not collect data from admitted patients in the central hospital for the indicator-based surveillance. This may have resulted in incomplete capture of cases and deaths and the observed low number of deaths compared to other MGs (Khan et al., 2018; Pane et al., 2019). However, any clustering of events was reported by physicians attending to indoor patients.

Based on our experiences in implementing an onsite disease surveillance system for the Prayagraj Kumbh MG, we recommend the following: (1) investment in disease surveillance as part of MG public health planning; (2) development of an ICC with epidemic intelligence capacity for early disease detection and response; (3) use of a Web-based reporting platform; (4) preparedness for the management of respiratory illnesses with epidemic potential; and (5) augmented laboratory diagnostic capability for outbreak-prone and high-consequence pathogens.

This onsite surveillance at Prayagraj Kumbh 2019 imparted a public health legacy for resource-constrained settings by successfully implementing an epidemic intelligence enabled surveillance system for early disease detection and response to monitor public health risks.

Author contributions

VA, TD, and PK contributed to the study design and implementation, and to the analysis and interpretation of the data; TD, AP, KKM, VTP, and PP contributed in writing the manuscript; RC, KKM, AT, AS, BSB, AK, DK, JS, RK, SSQ, PM, VV, KAD, GG, AM, VTP, PP, SK, AS, and MD contributed to study implementation; RC, SKJ, and SS contributed to the study design. All authors read and approved the final version of the manuscript.

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Ethical approval

Not required as this work was carried out as part of a public health response with prior approval of the National Centre for Disease Control, Delhi, India.

Conflict of interest

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.ijid.2020.09.1424>.

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