EDITORIAL

Note from the editors: Open access and sound science for rapid public health action 2
Eurosurveillance editorial team

RAPID COMMUNICATIONS

Whole genome sequencing suggests transmission of *Corynebacterium diphtheriae*-caused cutaneous diphtheria in two siblings, Germany, 2018 5
Anja Berger, Alexandra Dangel, Tilmann Schober, Birgit Schmidbauer, Regina Konrad, Durdica Marosevic, Sören Schubert, Stefan Hörmansdorfer, Nikolaus Ackermann, Johannes Hübner and Andreas Sing

Measles outbreak: preliminary report on a case series of the first 8,070 suspected cases, Manaus, Amazonas state, Brazil, February to November 2018 9
Guilherme Almeida Elidio, Giovanny Vinicius Araújo de França, Flávia Caselli Pacheco, Marinélia Martins Ferreira, Jair dos Santos Pinheiro, Eliane Nogueira Campos, Bernardino Cláudio de Albuquerque, Rosemary Costa Pinto, Angela Desiree Carepa Santos da Silva, Priscila Leal e Leite, Greice Madeleine Ikeda do Carmo, Andre Luiz de Abreu, Cintia Paula Vieira Carrero, Marli Rocha de Abreu, Fabiano Marques Rosa, Cesar M. de Oliveira and Dirce Bellezi Guilhem

PERSPECTIVE

Towards equity in immunisation 17
Tammy Boyce, Amelie Gudorf, Catharina de Kat, Mark Muscat, Robb Butler and Katrine Bach Habersaat

MEETING REPORT

A definition for community-based surveillance and a way forward: results of the WHO global technical meeting, France, 26 to 28 June 2018 21
Technical Contributors to the June 2018 WHO meeting
In 2018, public health experts and scientists concerned with the epidemiology and control of infectious diseases in Europe continued to be busy handling outbreaks and (re-)emerging infectious diseases; however, in contrast to recent years, there was no single overriding public health event that caught global attention. Nonetheless, there were developments that kept experts alert and that we editors followed with great interest.

Artificial intelligence (AI) continued to gain momentum and was widely acknowledged as an evolution that will fundamentally affect our societies and the ways that we generate knowledge. In the field of infectious disease, concrete examples of self-learning applications with some freedom of decision-making are still scarce. This was one of the messages from the 2018 Eurosurveillance seminar at ESCAIDE, Artificial intelligence (AI) in epidemiology: a reality in 2018? Discussions at this event also brought forward that now is a good time to tackle basic questions on ethics, infrastructure and training needs for epidemiologists and (public health) microbiologists related to AI. Such questions need to be addressed in an interdisciplinary collaboration with computer scientists, ethicists, social scientists and many others. We at Eurosurveillance will keep an eye on further developments on this topic, and we welcome the submission of articles in which authors share concrete examples of applied AI in public health and infectious disease epidemiology and surveillance.

The editorial team continuously strives to increase transparency of reporting, as well as the quality of articles published in Eurosurveillance. In 2018, we fine-tuned the authors’ instructions for outbreak articles. New instructions for surveillance articles were developed in collaboration with the editorial board and will be posted online soon. They should streamline and thus improve the presentation of surveillance data to boost the impact of this important feature of Eurosurveillance. From the beginning of 2019, Eurosurveillance has mandated the depositing of sequence data in open access public repositories ahead of submission, as well as the inclusion of ethical statements in regular articles. The journal’s editorial policy has endorsed the use of several reporting guidelines for many years, and starting in 2019 we will mandate that new submissions include checklists for certain article types: the PRISMA checklist for systematic reviews, the CHEERS checklist for health economic studies and the CONSORT checklist for clinical trials. While we strongly recommend that authors follow STROBE guidelines for the reporting of observational studies, we do not mandate the submission of STROBE checklists at present.

Support from reviewers, editorial board members, colleagues, our publisher the European Centre for Disease Prevention and Control (ECDC) and ECDC’s Director, as well as many others, has been invaluable in 2018. We are immensely grateful for the strategic and scientific advice, moral and day-to-day support and sustained funding that allows us to publish and disseminate information we deem to be sound science capable of informing public health decision-making.

Peer-review offers a great opportunity to engage experts in improving the quality of scientific work by adding new perspectives and insight, when reviews are conducted thoroughly and respectfully. We are aware that peer-review has been criticised as ineffective and biased by parts of the scientific community. Still, we believe it is a learning opportunity for both those giving feedback and those receiving it, and we editors who moderate this process profit considerably from everyone who gives their time and shares their expertise to guide us and authors. To support reviewers in their assessment of the completeness and comprehensiveness of manuscripts, we will send the
filled-in checklists submitted by authors together with the manuscripts for review, and we hope that reviewers will find this useful.

Our means to express our gratitude for support are limited. Traditionally, we publish a list with the names of all peer-reviewers at the beginning of each year to thank them. In 2018, nearly 500 individuals supported us with formal reviews [1], and we would like to extend our thanks to all those who may remain unnamed but who nonetheless provided helpful advice. In order to further recognise our peer-reviewers, we will send certificates to experts who completed more than one review in 2018. We are also happy to confirm review in 2018. We are also happy to confirm reviewing activities on recognised platforms such as Publons [2], upon request. Please do not hesitate to contact the editorial office if you need a certificate or confirmation in another way.

In 2018, we published 182 articles (52 Rapid communications, 115 regular articles, 15 other items such as editorials, letters and meeting reports). The 2018 acceptance rate of 26% was similar to previous years and, while we received submissions from around the world, the selection of articles was guided by relevance for public health in Europe and thus the vast majority of published articles were from Europe. Our Rapid communications, published within 2 to 3 weeks of submission, reported on ongoing or emerging threats to support rapid public health action, as we have done for many years. We covered events such as the nationwide outbreak of Salmonella Agona associated with internationally distributed infant milk products in France [3], the unusually early start of West Nile virus transmission season in Europe [4] and the upsurge of different enteroviruses associated with severe illness in some countries [5-7], and also published timely communications about influenza vaccine effectiveness [8-11].

We published several topical and special issues that collated data and evidence to support communication on specific topics, in some instances for particular health days or weeks. These issues covered important aspects of vaccination, HIV/AIDS and antimicrobial resistance, topics that continue to be high on our agenda. We hope that the articles we have published—such as those on the results from the 2016 to 2017 European point prevalence survey on antimicrobial use and healthcare-associated infections in acute and long-term care facilities [12]—serve as quality evidence to support effective public health decision-making.

The 2018 special issues resulting from dedicated calls for papers were ‘Screening and prevention of infectious diseases in newly arrived migrants in Europe’ and, in December, the first part of a special issue demonstrating how novel approaches in molecular diagnostics support traditional epidemiology and public health decision-making, the second part of which will follow at the end of January 2019. In February, we will launch a call for papers on the use of point of impact testing (POIT)/point of care testing (POCT) and self-testing in surveillance and epidemiology.

Various metrics showed that Eurosurveillance remained among the leading journals in its field in 2018. The journal’s most recent impact factor, released in mid-2018, was 7.1, ranking Eurosurveillance fifth in the category Infectious Diseases. The journal remained in the first quartile (for all categories listed) in the SCImago Journal Rank and Google Scholar metrics continued to be equally favourable. The Scopus-based CiteScore for Eurosurveillance improved from 3.7 to 5.0 and the CiteScore Percentile went up to 98%, corresponding to rank six among 478 journals in the category Medicine: Public Health, Environmental and Occupational Health.

Of relevance to our authors, reviewers and subscribers, 2018 also brought the new General Data Protection Regulation (GDPR) for Europe [13]. The GDPR caused concern for some, but reassured others that their privacy will be better protected. Eurosurveillance editors have long been sensitive to the need to protect the privacy of individuals and most GDPR requirements were already being followed before it came into effect. In light of the growing number of funders requesting instant open access for (community)-funded science, we would like to remind our authors and readers that Eurosurveillance is a well-recognised, open-access journal that provides a European platform for health professionals to share quality scientific findings in infectious disease epidemiology, prevention and control.

At Eurosurveillance we nurture close ties with our collaborators, authors, board members and colleagues at ECDC, and we enjoy this part of our work. It helps us develop the journal and identify topics of interest. Moreover, we gain insight into public health needs, which is crucial for our aim to be the authoritative and representative public health voice of the communicable disease community in Europe and beyond. Towards this objective, we aspire to provide facts and guidance for health professionals and decision-makers, to facilitate the implementation of effective prevention and control measures, and to support the preparedness and response to health threats in Europe through the rapid dissemination of high-quality, authoritative scientific information on relevant outbreaks or emergency situations. We look forward to fulfilling our aims in 2019, jointly with our contributors and many other supporters, and we wish all of them a productive and good year!

References


License and copyright

This is an open-access article distributed under the terms of the Creative Commons Attribution (CC BY 4.0) Licence. You may share and adapt the material, but must give appropriate credit to the source, provide a link to the licence, and indicate if changes were made.

This article is copyright of the authors, 2019.
Whole genome sequencing suggests transmission of *Corynebacterium diphtheriae*-caused cutaneous diphtheria in two siblings, Germany, 2018

Anja Berger¹,², Alexandra Dangel³, Tilmann Schober³, Birgit Schmidbauer⁴, Regina Konrad¹,², Durdica Marosevic³, Sören Schubert³, Stefan Hörmansdorfer², Nikolaus Ackermann², Andreas Sing¹,², Johannes Hübner¹, Birgit Schmidbauer⁵, Regina Konrad¹,², Durdica Marosevic², Sören Schubert⁶, Stefan Hörmansdorfer², Nikolaus Ackermann², Johannes Hübner⁷, Birgit Schmidbauer⁵, Regina Konrad¹,², Durdica Marosevic², Sören Schubert⁶, Stefan Hörmansdorfer², Nikolaus Ackermann², Johannes Hübner⁷

1. National Consiliary Laboratory for Diphtheria, Oberschleißheim, Germany
2. Bavarian Health and Food Safety Authority, Oberschleißheim, Germany
3. These authors contributed equally to this paper
4. Division of Pediatric Infectious Diseases, Hauner Children’s Hospital, Ludwig-Maximilians-University Munich, Munich, Germany
5. Department of Health and Environment, Munich, Germany
6. Max von Pettenkofer-Institute, Ludwig-Maximilians-University Munich, Munich, Germany
7. These authors contributed equally to this paper

Correspondence: Andreas Sing (andreas.sing@lgl.bayern.de)

Citation style for this article:

In September 2018, a child who had returned from Somalia to Germany presented with cutaneous diphtheria by toxigenic *Corynebacterium diphtheriae* biovar *mitis*. The child’s sibling had superinfected insect bites harbouring also toxigenic *C. diphtheriae*. Next generation sequencing (NGS) revealed the same strain in both patients suggesting very recent human-to-human transmission. Epidemiological and NGS data suggest that the two cutaneous diphtheria cases constitute the first outbreak by toxigenic *C. diphtheriae* in Germany since the 1980s.

Case reports
In early September 2018, a previously healthy school-aged child under 10 years old from a German family of Somali origin presented in our hospital in Germany with an initially non-healing burn wound. The wound had occurred 6 days earlier when spilling hot tea on the right thigh during a flight back from Somalia to Germany. The child and close family members had spent the prior 3 weeks in Somalia. Wound swabs initially only led to growth of *Streptococcus pyogenes*, but subsequent wound swabs starting 10 days later led to growth of a toxigenic, toxin-producing *Corynebacterium diphtheriae* biovar *mitis* strain (isolate: KL1235). Since the patient fulfilled both the German [1] and European Union [2] case definition for diphtheria, this prompted their immediate hospitalisation and isolation according to the German national guidelines [1]. The strain was identified by biochemical differentiation (API Coryne code 1010324) and matrix-assisted laser desorption/ionisation time-of-flight mass spectrometry (MALDI-TOF MS; MALDI Biotyper; Bruker Daltonics, Bremen, Germany) [3]. Antimicrobial drug susceptibility testing of the isolate was performed on Mueller–Hinton blood agar (supplemented with 5% sheep blood) by Etest after overnight incubation at 37°C and in 5% CO₂. Minimum inhibitory concentrations were determined according to Clinical and Laboratory Standards Institute (CLSI) [4] and European Committee on Antimicrobial Susceptibility Testing (EUCAST) guidelines [5]. The isolate was resistant against both penicillin G and erythromycin, but sensitive towards clindamycin and amoxicillin/clavulanic acid. Toxigenicity was verified in the German Consiliary Laboratory on Diphtheria, Oberschleißheim, by real-time PCR and a modified Elek test [6].

Public health measures including source tracing among household and other close contacts were taken according to German national guidelines [1]. This revealed that the case had a one-year-older sibling who concurrently had a skin infection. This child was affected by multiple superinfected insect bites on the leg, which were already present during the stay in Somalia. A swab taken from a leg wound also led to growth of a toxigenic, toxin producing *C. diphtheriae* biovar *mitis* strain (isolate: KL1242). The strain had the same API Coryne code and antimicrobial resistance profile as the one in the younger sibling’s isolate prompting the child’s immediate hospitalisation and isolation. In addition, *S. pyogenes* could be isolated from the patient’s wounds in high concentrations, and *Pseudomonas stutzeri*, *Pantoea* species and *Arconobacterium haemolyticum* were present in low concentrations.
To compare both *C. diphtheriae* strains, next generation sequencing (NGS) was carried out with both isolates as described previously, using Illumina Nextera XT libraries and an Illumina MiSeq [7]. Sequences were uploaded to the National Center for Biotechnology Information (NCBI) sequence read archive (SRA) [8], under BioProject PRJNA513482. Multilocus sequence typing (MLST) based on seven housekeeping loci [9] and extracted from the NGS data yielded sequence type (ST) 586 not previously found in the respective database [10]. NGS-derived core genome (cg)MLST comprising 2,154 target loci (1,553 core genome loci and 601 accessory genome loci) revealed no differences between the two isolates confirming strain identity. The NGS-based allelic profiles of the two isolates were compared with three Somali and eight additional East-African *C. diphtheriae* isolates from an outbreak among African refugees in 2015 with potential transmission before arrival in Europe [11], as well as to three German and seven isolates from patients with travel or migration history to or from different other countries. The comparison showed no significant connections to any of the other isolates (Figure).

Both cases recovered quickly after antibiotic therapy with amoxicillin/clavulanic acid and wound cleansing. They were discharged home after they repeatedly tested negative for nasopharyngeal and wound *C. diphtheriae* carriage according to German infection management recommendations [1]. Both cases were fully immunised according to the German childhood vaccination recommendations including a booster vaccination at 4-6 years of age [12], as were all their close family members with the exception of one parent whose vaccinations were completed thereafter. All close household contacts, i.e. the family, tested negative for *C. diphtheriae* carriage, were offered antibiotic prophylaxis and were advised to self-monitor for development of diphtheria-like symptoms according to German recommendations. Since the older sibling

Figure

Minimum spanning tree based on next generation sequencing-derived allelic profiles of *Corynebacterium diphtheriae* strains, to investigate two isolates from siblings with cutaneous diphtheria who had travelled to Somalia, Germany, 2018 (n = 23 isolates)

![Minimum spanning tree based on next generation sequencing-derived allelic profiles of *Corynebacterium diphtheriae* strains, to investigate two isolates from siblings with cutaneous diphtheria who had travelled to Somalia, Germany, 2018 (n = 23 isolates)](image-url)

- **Africa**: Somalia
- **Angola**: Travel but unknown location/route
- **Eritrea**: Tunisia
- **Ethiopia**: Sicily
- **India**: India
- **Poland**: Thailand
- **South America**: South America
- **Somalia**: Somalia
- **Tanzania**: Tanzania
- **Na**: no travel information available.

Next generation sequencing-derived allelic profiles of two isolates (KL1235 and KL1242) recovered from siblings in Germany who had prior travelled to Somalia were compared with the profiles of 21 isolates recovered from persons with or without travel to/from Somalia and other countries. Isolates are colour-coded according to the country where the persons stayed prior to *Corynebacterium diphtheriae* infection diagnosis.

The allelic profiles were based on 1,553 core genome and 601 accessory genome target loci. Allelic differences between the strains are indicated and clusters of closely related isolates with maximum distance of five alleles are shaded in grey.
reported to have demonstrated his superinfected insect bites to a large group of class mates, the local health department distributed leaflets on diphtheria among the school classes of both children. To date no secondary case has been detected.

Discussion

Classical respiratory and cutaneous diphtheria are caused by diphtheria toxin (DT)-producing *C. diphtheriae*, *C. ulcerans*, and *C. pseudotuberculosis* that are spread by droplets or – especially in the case of cutaneous diphtheria – by direct contact. Due to the potential local or systemic spread of DT, classical diphtheria may give rise to severe respiratory symptoms as well as myocarditis and polyneuritis with a fatality rate between 5 to 30% [13]. In contrast, cutaneous diphtheria symptoms may be mild, unspecific and masked by co-infections but may be a source of secondary transmission and respiratory disease [13,14].

Neither the human source nor the geographical origin of the isolated *C. diphtheriae* strain reported here are known. Both siblings had returned from a three-week stay in Somalia where diphtheria might be endemic according to the last available diphtheria incidence data reported to the World Health Organization [15]: in 2012 Somalia ranked seventh of all countries worldwide with respect to the number of notified cases. Moreover, cutaneous diphtheria was identified among Somali refugees to Europe in 2015 [11,16]. Cutaneous diphtheria cases have also been detected in Germany in recent years, albeit most, but not all of them, after travelling to endemic countries [11,16-18]. In the current report, the index case had received a burn wound on a flight from Somalia to Germany and presented at our hospital six days later, while back in Germany. Importantly, the swab which led to growth of *C. diphtheriae* was taken 16 days after the flight. There are several possible explanations for that: the child might have contracted the *C. diphtheriae* from their sibling who had reportedly acquired their subsequently superinfected insect bites when visiting Somalia. Supporting this hypothesis is the initial swab from the surgical department, in which *C. diphtheriae* was identified from their initial burn wound, the diphtheria outbreak obviouisly initiated within Germany. To our knowledge, this is the first diphtheria outbreak in Germany since the early 1980s when the last outbreak was described in Wuppertal using phage typing as molecular typing tool [20]. Interestingly, an NGS-based proof of strain identity between patients as in our outbreak has so far only been documented for two couples of respiratory diphtheria patients and two asymptomatic carriers during a diphtheria outbreak in South Africa [21]. After the 1980s, to our knowledge no secondary cases or carriers within Germany have been identified following either a respiratory or cutaneous diphtheria index case. In contrast, a cutaneous diphtheria patient from the United Kingdom with a travel history to Ghana was recently reported to have transmitted toxigenic *C. diphtheriae* to a close contact presenting with nasal diphtheria [22]. In conclusion, cutaneous diphtheria should not be forgotten and can present a possible source for secondary diphtheria cases, therefore prompting adequate hygienic precautions.

Acknowledgements

We thank Wolfgang Schmidt, Sabine Wolf, Jasmin Fräßdorf, Katja Meindl and Marion Lindermayer for excellent technical assistance.

Conflict of interest

None declared.

Authors’ contributions

AB, TS, SS, SH, RK, NA, JH were involved in laboratory work-up; AD performed NGS; AB, AD, JH, AS interpreted the results; AB, BS and DM were involved in epidemiological work-up; AB, BS, DM and AS were involved in public health management of the patients; TS and JH were involved in the clinical management of the patients. AB, AD, TS, JH and AS wrote the paper.

References


License and copyright
This is an open-access article distributed under the terms of the Creative Commons Attribution (CC BY 4.0) Licence. You may share and adapt the material, but must give appropriate credit to the source, provide a link to the licence, and indicate if changes were made.

This article is copyright of the authors or their affiliated institutions, 2019.

www.eurosurveillance.org
We report an ongoing measles outbreak in Manaus, Amazonas state, Brazil. As at 3 November 2018, 1,631 cases were confirmed corresponding to an incidence of 75.3 per 100,000 inhabitants; all five sanitary districts presented confirmed cases. Reintroduction of measles virus in Manaus is likely related to the current outbreak in Venezuela and due to recent decline in measles vaccine coverage. Given the current scenario, prevention and control measures should target individuals aged 15–29 years.

In February 2018, a measles outbreak was reported in the state of Roraima, Brazil and was found to be associated with the ongoing measles outbreak in Venezuela [1]. As at 10 December 2018, 349 cases have been confirmed [2]. Between 2001 and 2017, the Amazonas state did not report any confirmed measles cases [3]. Here, we report the ongoing measles outbreak in Manaus capital of the Amazonas state in Brazil. The north of Amazonas state borders Venezuela. Manaus has 2,145,444 inhabitants.

Case definition, laboratory testing and investigations

In 1969, the Ministry of Health (MoH) in Brazil established that all suspected measles cases seeking health services must be notified to the local authorities; cases must also be registered in the National System of Notifiable Diseases (Sinan) [4]. In addition, an ad hoc system known as ‘TRACK’ was made available in Manaus during the epidemiological week (EW) 19 (starting on 12 May 2018) to track register all data collected in the health services and through interviews in the present outbreak. In this study, we included all cases registered in TRACK until 3 November 2018 who lived in Manaus and met the suspected case definition (Box) [5-7].

In Brazil, all samples processed by the public health laboratory network are registered in the Laboratory Environment Management System (GAL); test results obtained in the ongoing outbreak available in GAL were also registered in TRACK to support case classification. The epidemiological and laboratory investigations, as well as contact tracing, were conducted by the Secretariat of Health of the municipality of Manaus, together with the Amazonas State Health Secretariat and the Brazilian MoH. All samples were sent to the National Reference Laboratory at the Oswaldo Cruz Foundation (Fiocruz) in Rio de Janeiro. Those who met the clinical criteria and presented laboratory confirmation were considered as ‘confirmed’.

Outbreak onset

The first laboratory confirmed case of the ongoing outbreak was a woman in her early 20s living in the northern district of Manaus. She had rash onset on 21 February 2018 and presented with fever, cough, coryza and conjunctivitis. She was identified during the investigation of her one-year old child’s case who had rash onset on 1 March and presented the same symptoms as the mother. Laboratory confirmation of measles was obtained on 23 March 2018.

The D8 genotype measles virus was identified in a urine sample from the infant, which was identical to
the one that is circulating in Venezuela; genotyping also showed that it was a wild-type measles virus. The mother reported having had contact with three Venezuelan migrants in January 2018, whom were interviewed by the surveillance team; one of them presented with malaise, diarrhoea, high fever and redness in the body soon after arriving in Manaus, but denied having presented with measles rash. None of the migrants had a history of vaccination against measles. The migrants did not match the case definition for notification and were identified retrospectively, 40 days after their symptom onset, therefore, laboratory tests were not carried out as too much time had elapsed. The infant did not have contact with the migrants during the incubation period; the only contacts were the mother and father, and the latter had been vaccinated against measles. Therefore, the probable source of infection of the infant was the mother.

Although the current available information suggest a link between the outbreaks in Venezuela and Manaus, further molecular epidemiological studies are needed to help understanding the reintroduction of measles in the municipality.

Epidemiological situation

From 6 February–3 November 2018, 8,070 suspected cases were notified; of these, 5,971 (74.0%) were still under investigation. Among the cases with complete investigation, 1,631 (77.7%) were confirmed and 468 (22.3%) were discarded; the median interval between the date of notification and the date of the final classification of the case was 37 days (range 0–140 days). All the confirmed cases were Brazilians. The incidence of measles among confirmed cases was 75.3 per 100,000 inhabitants; the incidence was higher among infants (1,003.9/100,000 inhabitants) and children aged 1–4 years (175.3/100,000 inhabitants). Up to 3 November, the northern district accounted for the largest number of cases (2,753 cases) (Table 1).

The epidemic curve shows a gradual increase in the number of cases with symptom onset from 6 May, reaching a peak of 763 cases in EW 29 (15–21 July), then decreasing gradually (Figure 1). The median reporting delay was 1 day (range 0–155 days), considering the difference between the notification and rash onset dates; therefore, the decrease in the number of notifications from the EW 30 onwards does not seem to be explained by the reporting delay. All five districts presented confirmed cases, which indicates the circulation of the virus throughout the municipality (Figure 2).

Of 7,602 notified cases, the majority (55.5%) were male; among women, 86 of 3,385 (2.5%) were pregnant. The age group with the highest number of cases (26.6%) was the 20–29-year-olds, followed by those aged 15–19 years (23.3%). Together, these two age groups comprised ca 50% of all notifications (Table 1). Up to week EW 22, most cases were in the age group of 6 months–4 years, from the EW 23 onwards, however, an increase of cases aged 15–29 years was observed (Figure 3A).
### Table 1

Key features of reported and confirmed measles cases, Manaus, Amazonas state, Brazil, 6 February–3 November 2018

<table>
<thead>
<tr>
<th>Variable</th>
<th>Notified cases a N = 7,602</th>
<th></th>
<th>Confirmed cases N = 1,631</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>Incidence per 100,000 inhabitants</td>
<td>n</td>
</tr>
<tr>
<td><strong>Sanitary district</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>2,454</td>
<td>32.3</td>
<td>460.1</td>
<td>525</td>
</tr>
<tr>
<td>North</td>
<td>2,753</td>
<td>36.2</td>
<td>461.5</td>
<td>506</td>
</tr>
<tr>
<td>West</td>
<td>1,011</td>
<td>13.3</td>
<td>211.3</td>
<td>290</td>
</tr>
<tr>
<td>South</td>
<td>1,325</td>
<td>17.4</td>
<td>253.4</td>
<td>270</td>
</tr>
<tr>
<td>Rural</td>
<td>59</td>
<td>0.8</td>
<td>418.2</td>
<td>40</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>3,385</td>
<td>44.5</td>
<td>355.2</td>
<td>755</td>
</tr>
<tr>
<td>Male</td>
<td>4,217</td>
<td>55.5</td>
<td>463.9</td>
<td>876</td>
</tr>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 6 months</td>
<td>549</td>
<td>7.2</td>
<td>2828.6 b</td>
<td>203</td>
</tr>
<tr>
<td>6–11.9 months</td>
<td>578</td>
<td>7.6</td>
<td>2828.6 b</td>
<td>197</td>
</tr>
<tr>
<td>1–4 years</td>
<td>746</td>
<td>9.8</td>
<td>489.9</td>
<td>267</td>
</tr>
<tr>
<td>5–9 years</td>
<td>314</td>
<td>4.1</td>
<td>160.1</td>
<td>100</td>
</tr>
<tr>
<td>10–14 years</td>
<td>355</td>
<td>4.7</td>
<td>166.3</td>
<td>116</td>
</tr>
<tr>
<td>15–19 years</td>
<td>1,770</td>
<td>23.3</td>
<td>853.1</td>
<td>225</td>
</tr>
<tr>
<td>20–29 years</td>
<td>2,021</td>
<td>26.6</td>
<td>467.3</td>
<td>332</td>
</tr>
<tr>
<td>30–39 years</td>
<td>830</td>
<td>10.9</td>
<td>229.0</td>
<td>101</td>
</tr>
<tr>
<td>40–49 years</td>
<td>319</td>
<td>4.2</td>
<td>113.8</td>
<td>61</td>
</tr>
<tr>
<td>50 + years</td>
<td>120</td>
<td>1.6</td>
<td>42.8</td>
<td>29</td>
</tr>
<tr>
<td><strong>Pregnancy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3,299</td>
<td>97.5</td>
<td>NA</td>
<td>744</td>
</tr>
<tr>
<td>Yes</td>
<td>86</td>
<td>2.5</td>
<td>NA</td>
<td>11</td>
</tr>
<tr>
<td><strong>Admitted to hospital</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>6,289</td>
<td>88.4</td>
<td>NA</td>
<td>1,164</td>
</tr>
<tr>
<td>Yes</td>
<td>823</td>
<td>11.6</td>
<td>NA</td>
<td>455</td>
</tr>
<tr>
<td><strong>Vaccination status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>5,411</td>
<td>75.0</td>
<td>NA</td>
<td>1,288</td>
</tr>
<tr>
<td>Yes</td>
<td>1,801</td>
<td>25.0</td>
<td>NA</td>
<td>265</td>
</tr>
<tr>
<td><strong>Signs and symptoms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cough</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>494</td>
<td>6.5</td>
<td>NA</td>
<td>48</td>
</tr>
<tr>
<td>Yes</td>
<td>7,101</td>
<td>93.5</td>
<td>NA</td>
<td>1,582</td>
</tr>
<tr>
<td>Coryza</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1,773</td>
<td>23.4</td>
<td>NA</td>
<td>235</td>
</tr>
<tr>
<td>Yes</td>
<td>5,809</td>
<td>76.6</td>
<td>NA</td>
<td>1,393</td>
</tr>
<tr>
<td>Conjunctivitis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3,188</td>
<td>42</td>
<td>NA</td>
<td>509</td>
</tr>
<tr>
<td>Yes</td>
<td>4,385</td>
<td>58</td>
<td>NA</td>
<td>1,114</td>
</tr>
</tbody>
</table>

NA: not applicable.

a Includes confirmed cases and those under investigation.

b Incidence based on all infants < 1 year.

Source: Municipal Health Secretariat of Manaus, Amazonas, Brazil. Data extracted on 6 November 2018.
Of 7,212 suspected cases, 75.0% had no records of vaccination against measles; the percentage was even higher among confirmed cases (82.9%) (Table 1). In addition, the majority of unvaccinated cases were in the age group of 15–29 years (Figure 3B).

Of the 7,602 suspected cases, 823 (11.6%) were hospitalised, and the average of the hospitalisation period was 4 days (Table 1). As of EW 29, two measles-related deaths had been recorded in the municipality of Manaus, both in male infants, aged 1 year or younger, below the age recommended for the first dose of measles vaccine, with no comorbidity; the D8 genotype was identified in one of the children and the other one is still awaiting genotyping.

Brazil vaccination schedule
MCV has been available free of charge in Brazil since 1967; currently, routine vaccination follows the calendar established by the MoH: one dose of measles, mumps, rubella (MMR) vaccine administered at 12 months of age; one dose of tetravalent vaccine against measles, mumps, rubella, varicella (MMRV) at 15 months; two doses of MMR between 2–29 years of age; and one dose of MMR from 30–49 years of age [4,8].

Official data from the MoH indicate that the coverage of the first dose of MMR vaccine at 12 months of age decreased markedly in Manaus between 2014 and 2017 (105.7% vs 81.0%); the same pattern was observed for the second dose of the vaccine at 15 months of age in the same period (95.8% vs 67.0%) [9]. It is noteworthy that vaccination coverage in Brazil is obtained through an administrative method [10]; a coverage above 100% indicates that the number of doses administered in the municipality is greater than the number of residents in a specific age group and time period.

Control measures
The management of the outbreak have been overseen by the MoH and coordinated by the local authorities. A situation room was established in Manaus in March 2018, in order to facilitate the coordination of all strategies for outbreak control and prevention. Since its creation, at least two deliberative meetings have been held weekly.

To date, several strategies have been adopted to interrupt the outbreak. Suspected cases have been investigated within 48 hours, searching for the source of infection and possible secondary cases. Extensive contact tracing for all measles cases has been conducted, verifying the immunisation status of contacts and vaccinating susceptible contacts within 72 hours. Self-isolation post exposure was also recommended. The epidemiological surveillance has been intensified through active and retrospective institutional case finding, including the identification of chains of transmission in the municipality. Initially, the local authorities requested immediate isolation of any suspected cases of measles; the percentage was even higher among confirmed cases (82.9%) (Figure 3B).
in reference hospitals. As the number of suspected cases increased substantially over time, hospitalisation became restricted to patients with complications given the limited availability of hospital beds.

Routine vaccination has been intensified in Manaus, free of charge for individuals aged 12 months—49 years. The vaccination campaign was anticipated, targeting children aged 12 months–5 years. It was conducted from 14–27 April 2018, and reached a coverage of more than 95% according to preliminary data provided by the MoH [11]. A national campaign was carried out from 6 August–31 October 2018, targeting individuals aged 12 months–5 years. Health professionals were hired and trained in case management and those with no record of vaccination against measles were vaccinated.

The laboratory network was strengthened, ensuring that samples were received at the reference laboratory within 5 days of collection. A risk communication strategy was implemented and media messages were disseminated, aiming to encourage vaccination when appropriate and advising the general population of the symptoms suggestive of measles. Epidemiological reports were made available weekly at the MoH webpage [12], as well as technical notes with guidelines on flows for epidemiological surveillance, laboratory and immunisation.

**Discussion**

The concentration of cases in children aged 5 years and under at the beginning of the outbreak seems to be related to a recent decrease in the coverage of measles-containing vaccines in Manaus, which may have led to a marked increase in the number of individuals susceptible to the disease in this age group. Consequently, this favoured the reintroduction of the virus in the municipality. In this context, the national vaccination

---

**Figure 2**

Spatial distribution of reported cases of measles according to investigation status, Manaus, Amazonas state, Brazil, 6 February–3 November 2018

Source: Municipal Health Secretariat of Manaus, Amazonas, Brazil. Data extracted on 6 November 2018.
**Figure 3**
Proportional distribution of reported cases of measles according to age group, stratified by (A) epidemiological week of notification and (B) vaccination status, Manaus, Amazonas, Brazil, 6 February–3 November 2018.

A. Reported cases of measles by epidemiological week of notification

B. Reported cases of measles by vaccination status

MMR: measles, mumps, rubella; MMRV: measles, mumps, rubella, varicella.

Vaccination status is based on the calendar for national routine immunisation established by the Brazilian Ministry of Health, as follows: one dose of MMR vaccine administered at 12 months of age; one dose of tetravalent vaccine against MMRV at 15 months; two doses of MMR between 2–29 years of age; and one dose of MMR from 30–49 years of age.

Source: Municipal Health Secretariat of Manaus, Amazonas, Brazil. Data extracted on 6 November 2018.
campaign targeting children aged 6 months–5 years seems to have been effective in controlling the spread of the virus in this age group. There was a change in the age distribution of the cases as the outbreak continued where more individuals aged 15–29 years were affected and the available data indicates that most of these individuals had no history of measles vaccination. As our findings are based on preliminary data, these observations should be further investigated in the future.

We acknowledge some limitations of our study. First, due to the magnitude of the outbreak it was not possible to carry out laboratory tests for all cases and most of the cases are still under investigation. Due to this, we opted to present the distributions of both notified and confirmed cases. In addition, there is need to consider the epidemiological link for case classification in future studies [13].

Second, it was not possible to collect detailed vaccination histories to analyse, as surveillance teams only recorded whether an individual had been vaccinated with MMR and if so, the date of the last dose.

Our findings highlight the need to increase the awareness among health professionals so that they can better recognise and report suspected cases of measles. In addition, epidemiological surveillance for timely investigation of cases could be strengthened, as well as better identification of likely sources of infection and secondary cases. Furthermore, given the potential number of susceptible individuals in all age groups, it is essential to intensify routine vaccination efforts and to implement catch-up vaccination, especially for those individuals aged 15–29 years. At national level, the risk of spread in Brazil is high, taking into account the transmissibility of the disease and the performance of the routine immunisation programme. At the regional level, the potential impact is also considered high given the prevention and control capacities in other countries in the Region of the Americas [14,15]. Efforts made in recent years to eliminate measles in Brazil may be compromised if effective measures are not taken to stop the transmission of the virus in the northern region of the country.

Acknowledgements
We gratefully acknowledge the contribution of colleagues from the Health Surveillance Foundation of Amazonas (FVSAM) and the Municipality of Manaus involved in outbreak investigation and reporting of suspected cases to the national surveillance system, especially Isabel Cristina Hernandez. We also thank the staff of the Brazil Ministry of Health and the Brazil Field Epidemiology Training Program (EpiSUS), especially Flávia Cardoso de Melo, for their support in the field investigations, and the international support provided by the Pan American Health Organization (PAHO/WHO). The authors wish to express their special thanks to Renato Vieira Alves for critically reading the manuscript and helpful discussion.

Conflict of interest
None declared.

Authors’ contributions
GAE, GVAF and FCP conceived the study design, led the data analyses, drafted the initial manuscript and invited comments from the wider authors.

MMF, JSP, BCA, RCP, ADCSS, PLL, GMIC, ALA coordinated outbreak control and investigation activities.

GAE, ENC, CPVC, MRA, FMR performed the epidemiological investigation.

CMO and DBG supervised and oversaw the manuscript production process.

Each author contributed to the content of the report and participated in drafting and revising the manuscript.

References


License and copyright

This is an open-access article distributed under the terms of the Creative Commons Attribution (CC BY 4.0) Licence. You may share and adapt the material, but must give appropriate credit to the source, provide a link to the licence, and indicate if changes were made.

This article is copyright of the authors or their affiliated institutions, 2019.
In the World Health Organization (WHO) European Region, differences in uptake rates of routine childhood immunisation persist within and among countries, with rates even falling in some areas. There has been a tendency among national programmes, policymakers and the media in recent years to attribute missed vaccinations to faltering demand or refusal among parents. However, evidence shows that the reasons for suboptimal coverage are multifactorial and include the social determinants of health. At the midpoint in the implementation of the European Vaccine Action Plan 2015–2020 (EVAP), national immunisation programmes should be aware that inequity may be a factor affecting their progress towards the EVAP immunisation targets. Social determinants of health, such as individual and household income and education, impact immunisation uptake as well as general health outcomes – even in high-income countries. One way to ensure optimal coverage is to make inequities in immunisation uptake visible by disaggregating immunisation coverage data and linking them with already available data sources of social determinants. This can serve as a starting point to identify and eliminate underlying structural causes of suboptimal uptake. The WHO Regional Office for Europe encourages countries to make the equitable delivery of vaccination a priority.

Despite the success of routine childhood immunisation programmes in reducing the incidence of vaccine-preventable diseases, immunisation uptake varies among countries, and among groups and districts within countries in the World Health Organization (WHO) European Region. There are also differences in coverage between the different scheduled vaccines. Inequity in uptake of routine vaccines has contributed to an accumulation of susceptible individuals in several countries of the Region [1,2] and hence also to the continued occurrence and spread of some vaccine-preventable diseases [3].

Inequities in health are associated with the social determinants of health, and inequities in immunisation are related to the concepts of social justice, fairness and ethics (Box 1)

Commitment to equitable extension of vaccination services
In 2014, all 53 countries in the Region committed to achieve the six goals and five objectives of the European Vaccine Action Plan 2015–2020 (EVAP) [4]. Unfortunately, progress towards Objective 3, equitably extending the benefits of vaccination to all, and towards Goal 4, meeting regional vaccination coverage targets, has been slow [5]. The tendency among many national programmes, policymakers and the media in recent years has been to attribute decreasing or suboptimal vaccination uptake to parental concerns about vaccines or refusal, but this is only part of the problem. Evidence shows that the reasons for suboptimal coverage are multifactorial, and social determinants and systems-related barriers can play an equally or more important role, depending on the context [6,7]. Targeted studies with the beneficiaries are needed to understand which barriers are most critical to address. EVAP’s Objective 3 specifically states that “the benefits of vaccination are [to be] equitably extended to all people” [4], however, this key pathway which will help reach EVAP goals has not yet been sufficiently explored or used.

At the midpoint of EVAP, all national immunisation programmes should investigate the extent to which equity is an issue that affects their progress towards EVAP’s goals and targets (Box 2).

Identifying inequities in immunisation
Acknowledging that immunisation coverage may be affected by social determinants is an important step in addressing those differences in uptake that arise from inequity in vaccine delivery and access.
National immunisation uptake statistics do not usually provide sufficient detail to identify which local populations are not fully vaccinated. There is a clear need to move beyond measuring the difference between worst- and best-performing geographical areas and to accurately identify who or which groups are not being immunised and where. Most countries that have undertaken to identify inequities in immunisation have found them – most often related to social determinants such as parental socioeconomic status, number of years in education and/or ethnicity [9-11].

Research on different vaccines in various countries has shown that immunisation uptake is related to the same factors associated with other health inequities and social determinants of health, e.g. parental number of years in education and level of income [12-16]. The collection and analysis of disaggregate data at district level has proven useful to identify where inequities exist. For example in Wales, disaggregate data are routinely used to monitor socioeconomic inequalities in vaccination coverage in 4-year-old children and have also revealed that socioeconomic inequities in uptake are largest for vaccinations scheduled for older children [17,18]. In Ireland, disaggregate data analysis led to identifying a large socioeconomic gradient in infant vaccination, a problem previously unknown and not addressed [19]. A range of similar studies exist, bearing witness to the correlation between vaccination coverage and social determinants and demonstrating the need for more countries to use similar methods to identify inequities in uptake [20-23].

From data to action
Treating all people the same will not necessarily reduce inequities in immunisation. There is no single way to ‘start’ to address inequities in immunisation, in some countries it may be necessary to develop policies, in others to adapt services, in others to develop systems to analyse and disaggregate data and in other countries to maintain and improve these disaggregate data. Addressing inequities is not a one-off action, it is a shift in conceptualising how services are delivered and how the goals and targets are set.

The first step in understanding inequities in immunisation is making inequities visible [20,21]. Understanding who is not immunised will help to understand why they are not immunised. Good quality, robust disaggregate data should be able to identify, map and track populations affected by inequities [22]. The goal should be for each country to analyse immunisation uptake data to identify presence or absence of inequities. This requires immunisation uptake data to be disaggregated by key determinants of inequities: (i) socioeconomic status, (ii) geographical location, (iii) educational status of parents and (iv) ethnicity and migration status.

Once pockets of un- or under-vaccination in specific geographic areas or among certain population groups are identified, national programmes can research the barriers that prevent some individuals from getting vaccinated (for example, barriers related to individual beliefs, attitudes and knowledge as well as those related to access, cost and service provision) and identify interventions to address them. Identifying underlying structural causes allows countries to design equitable immunisation services, remove barriers to immunisation and ensure that the benefits of immunisation reach every child [1,17,23-26].

Immunisation services alone cannot address the social determinants of health. However, immunisation programmes should consider these factors and adapt vaccine service delivery to meet the needs of all populations to increase uptake. If not seen and designed through an equity lens, immunisation programme activities can in fact increase inequity [27]. There is a growing body of research, including systematic reviews, showing that multi-component, locally designed interventions are most effective in reducing inequities in immunisation uptake [15,28]. Inequities are not resolved by providing the same immunisation services to all; they are resolved by providing different immunisation services that satisfy the needs of all.

### Box 1
Concepts of equity and immunisation

<table>
<thead>
<tr>
<th>Inequity in immunisation:</th>
<th>Avoidable differences in immunisation coverage between population groups that arise because barriers to immunisation among disadvantaged groups are not addressed through policies, structures, governance or programme implementation [4,8].</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equitable access to vaccines:</td>
<td>All individuals are offered the same vaccines through delivery services that are tailored to meet their needs.</td>
</tr>
<tr>
<td>Social determinants of health:</td>
<td>The underlying conditions in which people are born, grow, live, work and age [27]. These determinants include parental income, education, living standards, gender equity, distribution of power, policy frameworks and social values.</td>
</tr>
</tbody>
</table>

### Box 2
Critical actions in addressing inequities in immunisation

- Acknowledge that immunisation coverage may be affected by social determinants and that parental concern about vaccination is only one of several potential reasons for suboptimal uptake;
- Reveal and monitor disaggregate data to reveal inequities in uptake (e.g. by income of parent, geographical region, age, ethnicity);
- Conduct research to identify root causes of identified inequities;
- Apply an equity focus in all immunisation-related activities by first considering how population groups may be impacted differently;
- Ensure fair and inclusive structures, policies and decision-making that goes beyond prioritisation based on cost-effectiveness.
Flexible and opportunistic immunisation programmes and good relationships between healthcare services and parents appear to improve vaccination coverage and reduce inequities [29]. Flexible interventions and services involve considering where immunisations are delivered and who administers vaccines, as well as providing multiple offers of immunisation.

Where immunisations are delivered
Equitable immunisation programmes consider where it is easiest for families and individuals to be vaccinated. Vaccines can be delivered outside of health clinics, for instance in schools, pharmacies, community centres, hospitals or at home. For example, Belgium offered school-based vaccination against human papilloma-virus (HPV), which increased rates of vaccination initiation/completion and lowered inequalities based on socioeconomic factors [30].

Who administers vaccines
In some countries in the WHO European Region, only licensed family doctors are able to vaccinate. This may limit the flexibility of a service and add unnecessary costs. Enabling other healthcare workers such as nurses, midwives, school nurses and pharmacists to vaccinate may help increase equity. For example, in the UK, school nurses’ familiarity with their students and their established relationships with socially excluded communities were key to increasing uptake among girls who did not attend or who missed doses of the HPV vaccine [31].

Multiple offers of immunisation
The WHO Missed Opportunities for Vaccination strategy recommends any child or adult eligible for vaccination coming to a health service (for whatever reason) should be offered needed vaccines during their visit. This means offering vaccinations during visits to health services for curative services (e.g. treatment of fever, cough, injuries) or preventive services (e.g. parental classes), as well as offering them to accompanying family members [32]. For example, Scotland addressed inequities in their immunisation programme by offering vaccines many times and found it was “effective in minimising socioeconomic variation in the uptake of routine HPV immunisation in girls”. [33]

In the WHO European Region, some countries have mandatory vaccination policies, however, it is yet to be studied when and how such policies reduce inequities in immunisation uptake. Whether a country chooses to mandate vaccination or not, all 53 Member States of the Region have agreed to a set of immunisation goals in the European Vaccine Action Plan. It is up to the national health authorities to take measures suitable to their national context and ensure equitable and high immunisation coverage hereby protecting their citizens from life-threatening diseases.

The wider benefits of improving equity in immunisation uptake
Equitable immunisation policies, like all equitable health policies, generate wider health, social, political and economic benefits [34]. Immunisation is a powerful method to attract people into healthcare, especially the most vulnerable [35]. Improving equity in immunisation can therefore also improve coverage of other health interventions [6].

EVAP suggests that countries in the Region ensure that every individual is eligible to receive all appropriate vaccines, irrespective of their geographic location, age, gender, educational level, socioeconomic status, ethnicity, nationality or religious or philosophical affiliation [3]. Governments are tasked with creating fair and inclusive structures and policies, in partnership with immunisation teams, health professionals and the recipients of vaccines, all working together to reduce inequities in health and in vaccination uptake. To support this work, organisations such as the WHO Regional Office for Europe works continuously to share evidence and normative guidance and to help countries learn from each other’s work through the Tailored Immunization Programmes (TIP) [36]. The TIP helps countries identify the root causes of under-vaccination.

Conflict of interest
None declared.

Authors’ contributions
TB drafted the article and AG, CK, MM, RB and KBH all contributed to subsequent drafts.

References


License and copyright

This is an open-access article distributed under the terms of the Creative Commons Attribution (CC BY 4.0) Licence. You may share and adapt the material, but must give appropriate credit to the source, provide a link to the licence, and indicate if changes were made.

This article is copyright of the authors or their affiliated institutions, 2019.
Public health surveillance is used for the early detection of public health events and the monitoring of the health status of a population to guide and assess the impact of interventions [1].

In most settings, public health surveillance relies on information collected by healthcare facilities when patients come to seek treatment. This approach is limited in its ability to detect public health events and the occurrence of disease in populations that do not seek treatment at healthcare facilities or that experience barriers to treatment. This may be the case, for example, in hard-to-reach areas, areas where the population relies highly on traditional healers or alternative treatments, or in populations with stigmatising illnesses such as HIV infections. Engaging community members to collect health information from within their communities and report it for public health surveillance purposes is increasingly gaining interest as an approach to address such limitations. This approach is conventionally termed ‘community-based surveillance’ (CBS).

Surveillance strategies such as the Integrated Disease Surveillance and Response technical guidelines of the World Health Organization (WHO) Regional Office for Africa [2] acknowledge the role of community members in reporting cases of epidemic-prone diseases and unusual health events. CBS has been used in disease eradication programs including smallpox, guinea worm and polio [3], as well as during the West African Ebola virus disease outbreak of 2014–15, where community health workers and volunteers played a role in early detection and timely reporting to the health system [4].

To better understand the concept of and procedures for CBS, the Laboratory and Surveillance Strengthening team in the WHO Health Emergencies Programme undertook a systematic literature review. This review identified a lack of consensus on the terms and definitions available for CBS, along with a wide diversity in the characteristics of past and existing CBS.

These results highlighted the need for a meeting to convene country and partner representatives with experience in CBS implementation to: (i) collectively define the term ‘community-based surveillance’, (ii) identify good practices and challenges for CBS implementation and operation, and (iii) identify priority activities to support countries in implementing and strengthening CBS. In an effort to achieve these objectives, WHO organised a technical meeting on CBS on 26–28 June 2018 at the WHO office in Lyon, France. The meeting brought together 28 participants from several countries (Cameroon, Ghana, Mongolia, Sierra Leone, Thailand, UK) and partner organisations (Africa Centres for Disease Control and Prevention, CARE International, United States of America Centers for Disease Control and Prevention, CORE group, International Federation of Red Cross and Red Crescent Societies, International Rescue Committee, Norwegian Red Cross, World Vision International). A participatory methodology was used, with minimum plenary presentations; instead, the meeting consisted of working groups with various participatory methods (detailed agenda with full methodology available in Supplement S1).

**Definition of CBS**

A consensus definition of CBS was adopted: ‘CBS is the systematic detection and reporting of events of public health significance within a community by community members.’

The following characteristics of strong CBS were provided with the definition: it should be integrated in a formal surveillance structure, be actionable and timely, and have perceived benefits to the community, well-defined reporting mechanisms, a feedback mechanism and a monitoring and evaluation process.
Extensive discussions were held on the wording of the definition, and it was determined that the term ‘community’ should be clarified in annex of the definition. The consensus was that the definition of a community cannot be restricted to a certain geographical area; while it may be difficult to produce an all-encompassing definition of community, it is important that each CBS clearly defines its community under surveillance.

In addition, the following language specifications were suggested: use of the term ‘systematic’ instead of ‘system’ to avoid the connotation of CBS being a separate vertical system, while also ensuring that CBS is defined as a structured, formal process; use of the term ‘events’ to avoid the connotation of CBS being a separate system, while also ensuring that CBS is defined as the most defining aspect of CBS. The term ‘community member’ was defined as any person belonging to the community lacking social cohesion.

The consensus was that the definition of community member cannot be described as CBS. The latter was described as the most defining aspect of CBS. The term ‘community member’ was defined as any person belonging to the community under surveillance.

Subgroups of CBS needing specific guidance
Participants selected three CBS subgroups for further discussion, based on perceived importance, from 18 that had been proposed: (i) CBS in the context of a non-functioning routine surveillance system, (ii) CBS for hard-to-reach populations and (iii) CBS in a community lacking social cohesion.


of public health significance’ to encompass not only unusual events, but also any condition, disease or event that has implications for public health; specification of detection and reporting ‘by community members’ to imply that if event detection and reporting is conducted by a person not from the community itself, it cannot be described as CBS. The latter was described as the most defining aspect of CBS. The term ‘community member’ was defined as any person belonging to the community under surveillance.
After a thorough discussion, participants concluded that—in addition to generic CBS guidance and tools, which would apply in most situations—specific guidance and tools were only required for CBS in the context of a non-functioning routine surveillance system.

For CBS in hard-to-reach populations and communities lacking social cohesion, no specific additional guidance was identified as needed; however, these special contexts need to be addressed in any generic guidance and tools supporting CBS.

Good practices and challenges
Participants identified good practices in CBS implementation and operation (Box 1).

Participants also identified challenges in CBS implementation and operation, some of which overlapped with the good practices (Box 2).

Needs and gaps to replicate good practices and address challenges
Participants were presented with the existing CBS guidance and tools retrieved during a systematic literature review [4-9]. Available guidance and recommendations for data collectors were deemed more or less sufficient, though needing some updates, whereas many gaps were identified for the other aspects. While the existing guidance and tools address some of the identified needs, they are scattered across several documents, highlighting the need to consolidate them into one single guide or knowledge repository.

Participants expressed that any guidance or tool for CBS needs to be based on field experience that has been evaluated for effectiveness or based on appropriate research in different settings; further, it should be accompanied by case studies of good practices or illustrated with examples.

Activities to support CBS implementation and operation: the way forward
Based on the gaps identified as obstacles to replicating good practices and addressing challenges, participants selected 11 priority activities to support CBS implementation and operation, and ranked them through a scoring method [10] (methodology described in Supplement S1). These priority activities and the number of points they received are shown in Box 3.

Conclusion
The meeting achieved its expected outcomes by providing a consensus definition of CBS, a list of good practices and challenges for CBS, and a ranked list of priority activities to strengthen CBS. Participants expressed both willingness and motivation to contribute to these activities. Moving forward, they requested that WHO take a coordinating and facilitating role in the development of global standards of practices.

Technical Contributors to the June 2018 WHO meeting
José Guerra, World Health Organization (WHO), Lyon, France;
Yolanda Bayugo, World Health Organization (WHO), Lyon, France;
Pratikshya Acharya, World Health Organization (WHO), Lyon, France;
Michael Adjabeng, Ghana Health Service, Accra, Ghana;
Céline Barnadas, World Health Organization (WHO), Lyon, France;

Box 3
Priority activities to support community-based surveillance implementation and operation, ranked by score, WHO global technical meeting, France, 26–28 June 2018

- Develop and compile case studies of existing CBS, covering the lessons learnt, challenges and significant aspects of CBS (e.g. implementation, setting, purpose, actors, data collection and reporting, feedback and communication, monitoring and evaluation, community involvement, effectiveness, sustainability, costs). (143 points)
- Develop global CBS guidelines that bring together all of the existing guidance and tools, which are currently scattered over different documents, and fill existing gaps including guidance for hard-to-reach populations and communities lacking social cohesion. (114 points)
- Create a CBS community of practice with a repository of available material to act as an exchange channel for experts from different levels (e.g. regional, national) and for different areas (e.g. emergency setting, cross-border, mobile population). (111 points)
- Conduct a systematic literature review and additional research on incentives and motivating factors for CBS. (107 points)
- Develop a CBS resource library. (102 points)
- Develop CBS guidance to address hard-to-reach populations. (101 points)
- Conduct workshops on how to design a context-specific CBS. (97 points)
- Develop standard operating procedures for selection and training of CBS data collectors and supervisors. (83 points)
- Conduct research on One Health approach in CBS. (77 points)
- Develop communication packages to advocate for CBS. (75 points)
- Update the 2001 guide for CBS published by the Academy for Educational Development [5], including a section on protection from stigma. (51 points)
Acknowledgements

The authors alone are responsible for the views expressed in this article and they do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated.

Conflict of interest

None declared.

Authors’ contributions

José Guerra wrote the first draft of the manuscript. All Technical Contributors to the June 2018 WHO meeting critically reviewed the paper and approved the final manuscript.

License and copyright

This is an open-access article distributed under the terms of the Creative Commons Attribution (CC BY 4.0) Licence. You may share and adapt the material, but must give appropriate credit to the source, provide a link to the licence, and indicate if changes were made.

This article is copyright of the authors or their affiliated institutions, 2019.