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Emergence of vaccine-derived poliovirus type 2 after using monovalent type 2 oral poliovirus vaccine in an outbreak response, Philippines

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Objective: In response to an outbreak of circulating vaccine-derived poliovirus (cVDPV) type 2 in the Philippines in 2019–2020, several rounds of supplementary immunization activities using the monovalent type 2 oral poliovirus vaccine (OPV) were conducted for the first time in the Western Pacific Region. After use of the monovalent vaccine, the emergence of vaccine-derived poliovirus unrelated to the outbreak virus was detected in healthy children and environmental samples. This report describes the detection of this poliovirus in the Philippines after use of the monovalent type 2 OPV for outbreak response.

Methods: We describe the emergence of vaccine-derived poliovirus unrelated to the outbreak detected after supplementary immunization activities using the monovalent type 2 OPV. This analysis included virus characterization, phylogenetic analyses and epidemiological investigations.

Results: Three environmental samples and samples from six healthy children tested positive for the emergent vaccine-derived poliovirus. All isolates differed from the Sabin type 2 reference strain by 6–13 nucleotide changes, and all were detected in the National Capital Region and Region 4, which had conducted supplementary immunization activities.

Discussion: Since the 2016 removal of type 2 strains from the OPV, vaccine-derived poliovirus outbreaks have occurred in communities that are immunologically naive to poliovirus type 2 and in areas with recent use of monovalent OPV. To prevent the emergence and further spread of cVDPV type 2, several interventions could be implemented including optimizing outbreak responses by using the monovalent type 2 OPV, accelerating the availability of the novel type 2 OPV, strengthening routine immunization using inactivated polio vaccine and eventually replacing OPV with inactivated poliovirus vaccine for routine immunization.

Poliomyelitis is an acute viral infection of the nervous system caused by poliovirus types 1, 2 and 3. Polio has been eliminated in most countries globally through vaccination. Wild poliovirus type 2 was last seen in 1999 and was certified as eradicated in 2015. Oral poliovirus vaccine (OPV) remains the vaccine of choice for global polio eradication due to its ability to interrupt transmission of poliovirus by inducing mucosal immunity.[1] However, in underimmunized populations, the weakened vaccine virus from OPV may genetically mutate from the original attenuated strain and regain its neurovirulence, causing paralysis and outbreaks. Among the three Sabin strains in the OPV, before 2016 type 2 was estimated to cause 40% of all vaccine-associated paralytic polio and 90% of all cases of circulating vaccine-derived poliovirus (cVDPV).[2]

In April 2016, the poliovirus type 2 Sabin strain was removed from the trivalent OPV during the global switch to bivalent OPV to stop the emergence of VDPV from poliovirus type 2.[3] The inactivated poliovirus vaccine (IPV) had been introduced, but it provided only limited

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mucosal immunity to stop the spread of poliovirus, and at the time of the switch, there was a severe shortage of the IPV so that large cohorts of newborns were left unvaccinated.[4] As a result, the number of outbreaks from cVDPV type 2 (cVDPV2) has been increasing due to large gaps in population immunity to poliovirus type 2.[5] The expanding global cohort of children without the immunity against poliovirus type 2 that would prevent transmission could result in established endemicity of VDPV.[6]

To combat the growing threat of cVDPV2, several interventions could be implemented including optimizing outbreak responses by using the monovalent type 2 OPV, strengthening routine immunization by using IPV and accelerating the availability of the novel type 2 OPV. However, use of the monovalent type 2 OPV to control outbreaks of cVDPV2 carries the risk of seeding emergent strains of VDPV2 that have the potential for further circulation.[7] This has been observed through molecular epidemiological analysis of cVDPV2 outbreaks that resulted from suboptimal coverage of supplementary immunization activities (SIAs) that used the monovalent type 2 OPV within outbreak response zones or in contacts travelling outside of response zones.[6,7] Therefore, use of the monovalent type 2 OPV in outbreak responses is governed by the strict criteria of the protocol of the Global Polio Eradication Initiative (GPEI) and the decision to release the monovalent type 2 OPV from global stocks, authorized by the Director-General of the World Health Organization (WHO) based on the recommendations of the GPEI's Eradication and Outbreak Management's advisory group.

On 19 September 2019, a polio outbreak was declared by the Department of Health in the Philippines after confirmation of cVDPV2 in a child with acute flaccid paralysis (AFP) that was reported from Lanao Del Sur Province in the Bangsamoro Autonomous Region of Muslim Mindanao (BARMM). The index child was a 3-year-old girl with no history of polio vaccination and onset of paralysis on 26 June 2019. Poliovirus collected from stool in July 2019 had 65 nucleotide changes from the Sabin type 2 reference strain and was genetically linked to isolates collected from July to August in environmental samples in Manila, National Capital Region (NCR) and Davao (Mindanao), confirming widespread circulation of VDPV2 within the Philippines.

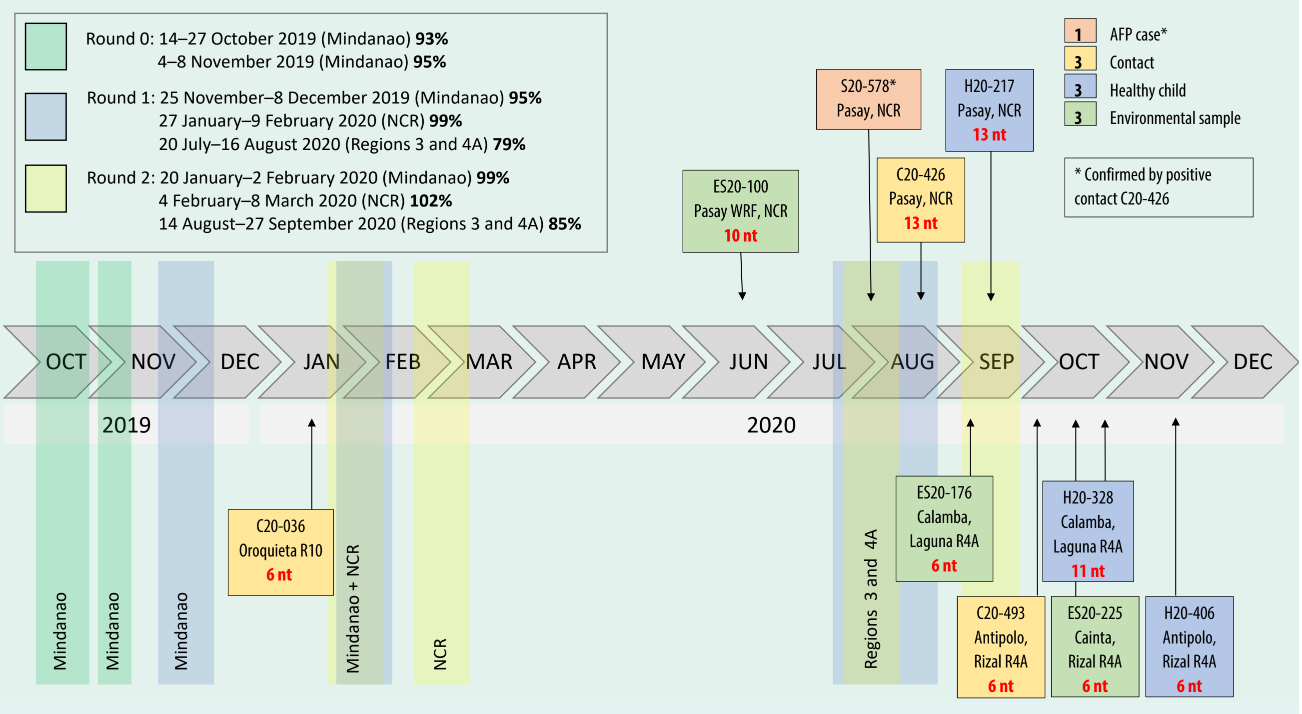
From June 2019 to March 2021, a further 20 stool samples from 13 AFP cases, two contacts of AFP cases and five healthy children, plus 23 environmental samples tested positive for cVDPV2. Geographically, this outbreak occurred in the Luzon and Mindanao groups of islands, with concentrated virus detection in BARMM and NCR and other regions, including Regions 3, 7, 10, 11 and 12. Analyses revealed that these isolates were genetically linked to one another, and had between 61 and 71 nucleotide changes from the Sabin type 2 reference strain. The last cVDPV2 isolate from a human came from a stool sample from a 1-year-old child from Cabanatuan City, Nueva Ecija, who had onset of paralysis on 15 January 2020. The last cVDPV2 isolate detected in an environmental sample was collected on 16 January 2020 from the Butuanon River in Mandaue City, Region 7.

Along with the cVDPV2 outbreak, VDPV2 was isolated in August 2019 from stool samples from an AFP case with a primary immunodeficiency disorder residing in Laguna, Region 4A. Genetic analysis showed 64–107 nucleotide changes for this isolate compared with the Sabin type 2 reference strain, but it was not genetically linked with any other isolates from other sources in the country.

The use of the monovalent type 2 OPV for the cVDPV2 outbreak response in the Philippines was approved on 24 September 2019. From October 2019 to December 2020, 15 SIAs were completed in outbreak-affected areas, utilizing more than 13 million doses of monovalent type 2 OPV and achieving coverage of 79% to 102% (**Fig. 1**). However, within 30–120 days of monovalent type 2 OPV use, isolates of emergent VDPV2 were detected in several areas where the outbreak response had taken place, and these had between 6 and 13 nucleotide changes from the Sabin type 2 reference strain, which suggests the emergence of a new strain. As there was no evidence of circulation, they were classified as ambiguous VDPV2.

This report summarizes the emergence of VDPV2 following use of the monovalent type 2 OPV to respond to the cVDPV2 outbreak in the Philippines, and it contributes to the regional and global knowledge about and experience of the risks related to the use of monovalent type 2 OPV and possible preventive and mitigation activities.

Fig. 1. **Timeline of supplementary immunization activities using the monovalent type 2 oral poliovirus vaccine and identification of ambiguous isolates of vaccine-derived poliovirus type 2, the Philippines, 2019–2020**



Percentages in bold are coverage rates.

AFP: acute flaccid paralysis; aVDPV2: ambiguous vaccine-derived poliovirus type 2; NCR: National Capital Region; nt: nucleotide changes; R: Region; WRF: Water Reclamation Facility.

METHODS

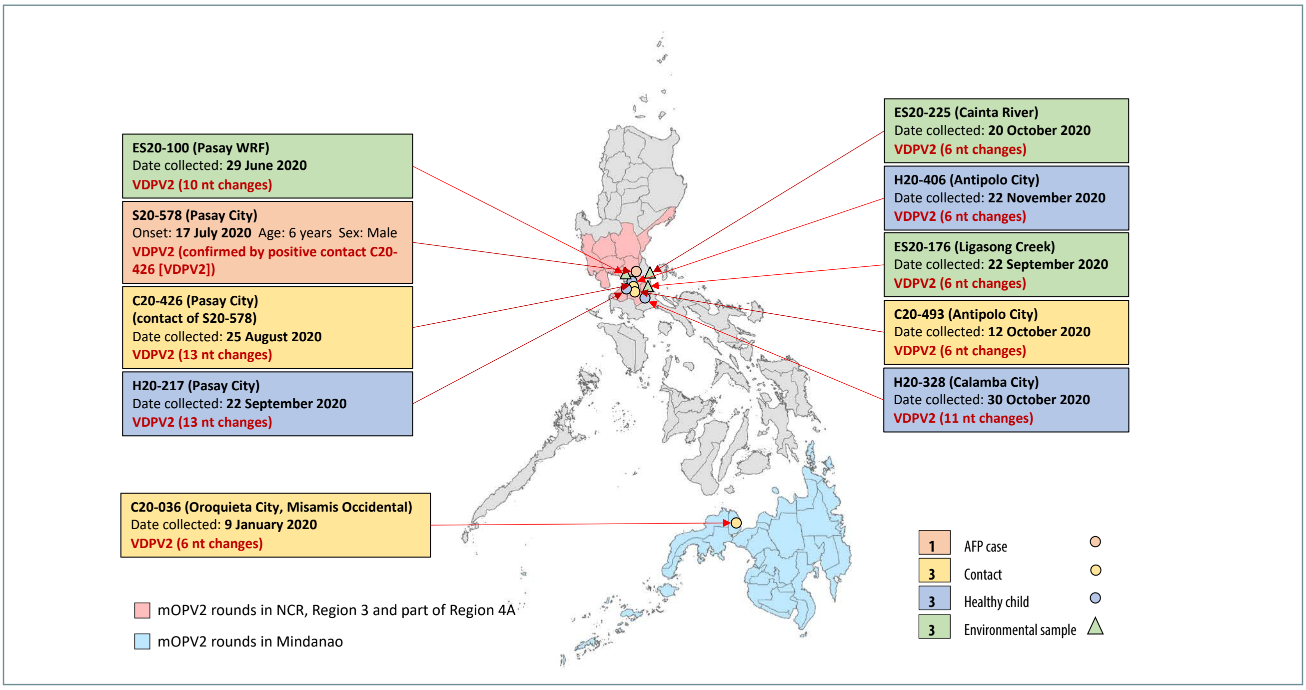
The polio surveillance system in the Philippines follows the GPEI protocol and includes AFP surveillance conducted by the Epidemiology and Surveillance Units of the Department of Health.[8] This is supplemented by environmental surveillance conducted by the polio team at the Research Institute for Tropical Medicine, whereby environmental samples are collected from all 17 regions.[9] At the Research Institute, all samples undergo testing for concentration of sewage, virus culture and intratypic differentiation for serotyping of polioviruses. Every poliovirus type 2 isolate and discordant (non-Sabin) poliovirus types 1 and 3 isolates are sent to the National Institute of Infectious Diseases in Japan for phylogenetic analyses using standardized WHO methods.[10] Samples are sequenced and phylogenetic trees are developed to determine the genetic linkage of the polioviruses and their relatedness to the Sabin strain and to one another. Using a global database of known cVDPVs, the genetic linkage of newly detected VDPVs to known VDPVs can be determined. We analysed demographic, clinical and laboratory information recorded in the polio surveillance database and describe the emergent VDPV2 isolates in relation to the timeline of the SIAs that used the monovalent type 2 OPV (**Fig. 1**). This analysis included findings from virus characterization, phylogenetic analyses and epidemiological investigations.

RESULTS

From October 2019 to December 2020, three environmental samples and six healthy children tested positive for new VDPV2 unrelated to the outbreak virus. All isolates had between 6 and 13 nucleotide changes from the Sabin type 2 reference strain, and all were detected in NCR and Region 4, the regions that conducted SIAs using monovalent type 2 OPV (**Fig. 2**).

The first emergent VDPV2 strain was detected in stool from a close contact of an AFP case in Misamis Occidental Province, Region 10, in January 2020. This

Fig. 2. **Spot map of ambiguous vaccine-derived poliovirus type 2, the Philippines, 2019–2020**



AFP: acute flaccid paralysis; aVDPV2: ambiguous vaccine-derived poliovirus type 2; mOPV2: monovalent type 2 oral poliovirus vaccine; NCR: National Capital Region; nt: nucleotide changes; WRF: Water Reclamation Facility.

Table 1. **Isolates of emergent vaccine-derived poliovirus type 2 collected from children in the Philippines, 2019–2020**

Case no. (case identifier)	Age, sex	City, region	No. of OPV or IPV doses received	Date of stool collection	Result	No. of nucleotide changes from the Sabin type 2 reference strain
1 (C20-036)	3 years, female	Oroquieta City, Misamis Occidental	5	9 January 2020	aVDPV2	6
2 (S20-578)	6 years, male	Pasay City, National Capital Region	3	1: 12 August 2020 2: 13 August 2020	Both negative	Close contact (C20-426) was positive
3 (C20-426)	1 year, male	Pasay City, National Capital Region	5	25 August 2020	aVDPV2	13
4 (H20-217)	7 months, male	Pasay City, National Capital Region	1	22 September 2020	aVDPV2	13
5 (C20-493)	2 years, male	Antipolo City, Rizal	4	12 October 2020	aVDPV2	6
6 (H20-328)	2 years, male	Calamba City, Laguna	3	30 October 2020	aVDPV2	11
7 (H20-406)	1 year, male	Antipolo City, Rizal	2	22 November 2020	aVDPV2	6, 7

aVDPV2: ambiguous vaccine-derived poliovirus type 2; IPV: inactivated poliovirus vaccine; OPV: oral poliovirus vaccine.

Table 2. **Isolates of emergent vaccine-derived poliovirus type 2 collected in environmental samples, the Philippines, 2020**

Sample no. (sample identifier)	Site	Round no. and date of supplementary immunization activity using monovalent type 2 oral poliovirus vaccine in area	Date of collection	Result	No. of nucleotide changes from the Sabin type 2 reference strain
1 (ES20-100)	Pasay Water Reclamation Facility Pasay City, National Capital Region	1: 27 January–8 February 2020 2: 24 February–7 March 2020	29 June 2020	aVDPV2	10
2 (ES20-176)	Ligasong Creek Calamba City, Laguna	1: 3–30 August 2020 2: 14–27 September 2020	22 September 2020	aVDPV2	6
3 (ES20-225)	Cainta River Cainta, Rizal	1: 24 August–6 September 2020 2: 14 September–1 October 2020	20 October 2020	aVDPV2	6

aVDPV2: ambiguous vaccine-derived poliovirus type 2.

was within 60 days of the first SIA delivering monovalent type 2 OPV in Mindanao in 2019. The case was a 3-year-old girl who received her first dose of the monovalent type 2 OPV during the SIA in November 2019. Genetic analysis of the isolate showed six nucleotide changes from the Sabin type 2 reference strain and revealed no genetic link to other cVDPV2 isolates.

The second emergent VDPV2 isolate was detected in an environmental sample from Pasay City, NCR, in June 2020. This was within 120 days of the SIAs using the monovalent type 2 OPV in NCR. The virus had 10 nucleotide changes from the Sabin type 2 reference strain and was not genetically linked to other known VDPV2 isolates. Following this detection, further investigations were conducted, including searching for AFP cases, conducting a household survey and collecting stool samples from healthy children in high-risk barangays (the smallest administrative unit in the Philippines) in the catchment area of the environmental surveillance site in Pasay City. These case-finding efforts identified a 6-year-old boy with paralysis whose stool samples were negative for poliovirus due to inadequate samples; however, the stool sample collected from his close contact, a 1-year-old boy, tested positive for VDPV2 and had 13 nucleotide changes from the Sabin type 2 reference strain. The close contact had received two doses of the monovalent type 2 OPV during the SIAs in January and February 2020. In the high-risk barangays neighbouring the barangay with the AFP case, stool samples were collected from healthy children, and a 7-month-old boy was identified who also tested positive for VDPV2 and whose sample had 13 nucleotide changes from the Sabin type 2 reference strain. This child had received one dose of the monovalent type 2 OPV during the SIA in March.

Similarly, emergent VDPV2 isolates with six nucleotide changes from the Sabin type 2 reference strain were detected in environmental samples in Calamba, Laguna, in Region 4 in September 2020, within 30 days of the SIA using the monovalent type 2 OPV in Laguna Province. Heightened AFP surveillance was conducted in the city, which led to the detection of emergent VDPV2 in the stool sample of a healthy 2-year-old child. This child had received two doses of the monovalent type 2 OPV during the SIAs in Laguna in August and September 2020, and a stool sample was positive for VDPV2, and had 11 nucleotide changes from the Sabin type 2 reference strain, within 45 days after the last dose of the monovalent type 2 OPV.

In Antipolo, Rizal, a close contact of an AFP case tested positive for VDPV2 in November 2020. The close contact was a 2-year-old boy who had received two doses of the monovalent type 2 OPV during the SIAs in August and September 2020 in Rizal Province, Region 4. The isolated poliovirus had six nucleotide changes from the Sabin type 2 reference strain. This case triggered a household survey of healthy children in the affected barangay and other high-risk barangays. A healthy 1-year-old child who had not received any doses of the monovalent type 2 OPV during an SIA tested positive for VDPV2, and the isolate had six nucleotide changes.

Lastly, in a neighbouring municipality in Cainta, Rizal Province, emergent VDPV2 was detected in an environmental sample from the Cainta River in October 2020, within 60 days after the SIA using the monovalent type 2 OPV; the environmental isolate had six nucleotide changes. A summary of the isolates is given in **Tables 1** and **2**.

DISCUSSION

In response to the cVDPV2 outbreak in the Philippines that comprised 20 cVDPV2 cases and contacts, 15 SIAs were conducted between October 2019 and December 2020 using the monovalent type 2 OPV. More than 13 million doses of the monovalent type 2 OPV were utilized. However, within 60–120 days of some of these SIAs, the emergent VDPV2 isolates were detected in the areas targeted by the outbreak response. These isolates were identified in the close contact of a child with paralysis, six healthy children and three environmental samples. All isolates had between 6 and 13 nucleotide changes from the Sabin type 2 reference strain and no genetic linkage to previously detected VDPVs in the Philippines.

Outbreaks of cVDPV are caused when the live, attenuated virus used in vaccines regains its neurovirulence, particularly in settings with chronically low coverage of routine and supplementary polio immunization or in immunodeficient individuals.[11] The risk of further cVDPV will persist while any of the three Sabin strains are used for vaccination, either in the bivalent OPV or the monovalent type 2 OPV. Of the three types of VDPVs, the risk of cVDPV2 outbreaks is highest because more than 3 years have passed since cessation of the use of the Sabin 2 vaccine strain, which has led to a decrease in mucosal immunity against type 2 poliovirus. Any VDPV2 emergence has the potential to cause outbreaks in populations that are immunologically naive to poliovirus type 2. A similar situation was observed in Central and Western Africa in 2019, where VDPV2 cases primarily affected type 2-naive children born after the switch from trivalent OPV to bivalent OPV.[7]

This cycle of polio associated with VDPV is likely to continue when a cVDPV2 outbreak response uses the monovalent type 2 OPV to interrupt transmission. The detection of emergent VDPV2 in the Philippines should serve as a warning not only for the Philippines but also for other countries with suboptimal coverage of routine polio immunization.

The risk of future cVDPV2 outbreaks appears to be a closer reality, given the scenario of fading type 2 immunity in OPV-using countries coupled with recent use of the monovalent type 2 OPV. In fact, the risk of a cVDPV outbreak is inevitable while there remain subpopulations with chronically low coverage of polio immunization and the use of any type of OPV continues in routine and supplementary polio immunization activities.

Live OPVs remain the workhorses of polio eradication programmes due to their ability to interrupt transmission. Since the removal of type 2 poliovirus from the OPV in 2016, the majority of cVDPV2 outbreaks reported globally have been detected in areas that recently used the monovalent type 2 OPV or in areas that border those where the monovalent type 2 OPV was used, reflecting the risk of VDPV2 emergence after the Sabin type 2 vaccine strain was used in the period after the vaccine changed.[6] To prevent the emergence and further spread of cVDPV2, several interventions could be implemented, including optimizing responses to outbreaks by using the monovalent type 2 OPV, strengthening routine immunization using IPV, accelerating the availability of the novel type 2 OPV and eventually replacing OPV with IPV for routine immunization after carefully considering epidemiological and programmatic aspects. This report summarizes the findings of the investigation into the emergence of a VDPV2 outbreak in the Philippines that occurred after the monovalent type 2 OPV was used during 2019–2020, and it adds to the growing global evidence of VDPV2 emergence in the period after the vaccine changed.

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Tropical Medicine, Philippines, and the National Institute of Infectious Diseases, Japan, for providing the results and the phylogenetic analyses.

Conflicts of interest

The authors declare no competing interests.

Ethics statement

No ethics approval was required as this investigation was part of emergency response activities.

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Conducting verbal autopsy by telephone interview during the pandemic to support mortality surveillance: a feasibility study in Malaysia

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Objective: Verbal autopsy (VA) through face-to-face interviews with caregivers is a way to determine cause of death without medical certification. In Malaysia, the use of VA has improved mortality statistics. However, during the coronavirus disease 2019 (COVID-19) pandemic, face-to-face interviews were delayed, reducing VA data collection and affecting data for mortality surveillance. This study aims to investigate the feasibility and acceptability of conducting VA interviews via telephone calls, and the quality of the data gathered.

Methods: The study was conducted in Malaysia from September to October 2020 using a cross-sectional design. Participants were health-care workers from established VA teams across the country. They conducted VA interviews via telephone and provided feedback through a customized online form. Data collected from the form were used to assess the feasibility, acceptability and quality of the telephone interviews using IBM SPSS version 23.

Results: Responses were received from 113 participants. There were 74 (65.5%) successful interviews, representing 91% of the 81 cases who were able to be contacted. More than two thirds of health-care workers provided positive feedback on the telephone interview method for themselves and the interviewees. Only 10.8% of causes of death were unusable.

Discussion: This study provides preliminary evidence that VA via telephone interview is feasible, acceptable and can be used as an alternative to face-to-face interviews without affecting data quality. During times when face-to-face interviews are not advisable, VA telephone interviews can be used for data collection for mortality surveillance.

Verbal autopsy (VA) is a method developed by the World Health Organization (WHO) to determine the cause of death when medical certification is not available.[1] Death without medical certification usually happens at home, and the cause of death is determined by a police officer or the decedent's caregiver. Without medical attention, the cause is often given as "old age" – such an ill-defined cause of death does not provide useful information for mortality surveillance and leads to inaccurate population health assessment.[2] In 2016, 47.2% of deaths registered in Malaysia were nonmedically certified deaths (NMCDs).[3] Reducing NMCDs would strengthen mortality statistics and contribute to better health planning.[4]

Malaysia incorporated VA into the death registration system in 2017 to improve mortality data.[5] VA is conducted via a face-to-face interview between a trained health-care worker and the decedent's caregiver. The interviewer uses a standardized VA questionnaire to collect information on the events that led to the decedent's death; the questionnaire is then sent to a physician for cause of death determination.[6–8] Since implementation of VA, the number of NMCDs reduced from 47.2% in 2016 to 37.2% in 2019.[3,9]

During the coronavirus disease 2019 (COVID-19) pandemic, the face-to-face VA process has been delayed due to the physical distancing preventive measures implemented.[10] Therefore, telephone interviews were trialled as a substitute for the standard face-to-face method because such interviews comply with the physical distancing measures of the ongoing COVID-19 pandemic. Additional benefits of a telephone interview include cost,

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time–effectiveness and physical anonymity, which may be appropriate given the sensitive nature of the interview questions.[11] These benefits, plus any challenges of using telephone interviews and whether the telephone interview method affects the quality of the data obtained from the interview, need to be investigated before implementation. Therefore, the aim of this study was to assess the feasibility, acceptability and data quality of the VA interviews when conducted via telephone in Malaysia in 2020.

METHODS

Study design and sample selection

An exploratory cross-sectional study was conducted to determine the feasibility, acceptability and data quality of performing VA interviews via telephone. The participants for this study were health-care workers employed under Malaysia's Ministry of Health, who were members of the District Health Office VA teams.

The sampling frame for this study was deceased individuals who died between 1 and 31 January 2020 and who were on the list of VA cases. This list was extracted from the NMCD registry, obtained from the Disease Control Division of Malaysia's Ministry of Health. The list included the details of the deceased and the contact information of their principal caregivers. The VA cases were randomly selected to include cases from both urban and rural areas from across Malaysia. Because this was a feasibility study, 100 VA cases were selected. Each VA case was assigned to a health-care worker for a telephone-based VA interview by the coordinator of the relevant District Health Office VA team. The study team was not involved in the assignment of the VA cases to the health-care worker and had no influence on the selection. The health-care workers were identified and approached to be included in the study only after a case had been assigned to them.

Survey process and survey instrument

For each assigned case, the health-care worker contacted the corresponding caregiver and conducted the interview with that person by telephone instead of face-to-face. The VA interview was completed according to Malaysia's VA guidelines and procedures, using the standardized Malaysian VA questionnaire.[6,7] The health-care worker did not meet the caregiver and only interacted through the telephone call. After the interview, the health-care worker submitted the collected information to a physician in their district for cause of death determination as per the usual process. The determined cause of death was then sent to Malaysia's Health Informatics Centre for data coding using the 10th revision of the International Classification of Diseases and Related Health Problems (ICD-10).

The health-care workers then provided their feedback on the telephone interview process, and their perception of how the caregivers reacted to being interviewed via telephone, via an online form. The form was a structured questionnaire designed in collaboration with public health experts from the Malaysian Institute for Public Health and the Disease Control Division, Ministry of Health Malaysia, and with a WHO consultant with expertise in mortality statistics, VA procedures and VA formulation in Malaysia. The questionnaire contained 53 items divided into five sections, which included the health-care worker's characteristics, the deceased individual's characteristics, the interview settings and outcomes, the caregiver's characteristics and their reactions towards the telephone interview as perceived by the health-care worker, and the health-care worker's own assessment of the telephone interview (see **Supplementary material**). This form was subsequently translated into Malay and made available online via Google Forms.

Consent from the health-care workers was obtained at the top of the online feedback form. Consent from the caregivers was only sought for the VA interview; it was obtained verbally and documented in the corresponding VA questionnaire. Further consent for the feasibility study was not warranted. Data collection was conducted between September and October 2020, resulting in a recall period of 8–9 months. Data collected from the VA questionnaire were managed according to Malaysia's VA guidelines and procedures by the corresponding health-care workers. The data from the feedback form and the determined causes of death were compiled for analysis.

Variable definition and analysis

Feasibility

The feasibility of the telephone interview was determined by the proportion of successful outcomes, defined as a complete VA questionnaire and a cause of death determined. Data from the VA telephone interview feedback form were merged with the cause of death assigned by the physicians to determine the outcome. Statistical analysis was conducted to assess the association between the interview outcomes and the characteristics of the cases and health-care workers administering the VA, and whether the call was completed using an office or personal phone.

Acceptability

Acceptability was assessed from the health-care workers' feedback and their perceived reactions of the caregivers towards the telephone interview process. Among the successful outcomes, the caregivers' perceived reactions were analysed in terms of their trust, question comprehension and cooperation throughout the telephone interview. Health-care workers' feedback was analysed in terms of the limitations, comfort and their perceived ability to convey complicated questions during the telephone interview process.

Data quality

The quality of determined cause of death using ICD-10 codes was reviewed based on the proportion of causes of death without garbage code categories (a garbage code being any code that should not be the underlying cause of death, is insufficiently specified[12] or is unusable[13]). Associations between the quality of cause of death data and the health-care workers' background were analysed by chi-square analysis using SPSS Statistics version 23.

RESULTS

A total of 116 deceased cases were selected from across Malaysia, among which VA telephone interviews were attempted for 113 (97.4%). Reasons for non-response from the remaining three cases were not documented.

Feasibility

There were successful outcomes for 74 of 113 cases (65.5%). Of the 39 unsuccessful outcomes, seven cases (18.0%) were contactable but failed to complete the interview due to the caregiver's distrust, disagreement or language barrier issues. Among the remaining 32 unsuccessful cases, 46.2% did not answer the call, 20.5% had incorrect telephone numbers and 15.4% did not have an available telephone number. Of the 81 cases that were contacted, 74 (91.4%) had successful outcomes.

Cases from the north-east zone (80.6%) had the highest number of successful outcomes, whereas the Borneo zone (45.2%) had the lowest, and the difference was significant. There was no significant difference in interview outcomes between urban and rural localities, or by the health-care workers' sex, profession, experience with VA interviews or whether an office or personal telephone was used (**Table 1**).

Acceptability

The health-care workers rated most caregivers as having "easy" trust towards health-care workers, questionnaire comprehension and interview cooperation (86.5%, 87.8% and 95.9%, respectively) throughout the telephone interview (**Table 2**). A significantly higher proportion of health-care workers rated questionnaire comprehension as "difficult" for caregivers aged 60 years and over (42.9%; $P=0.018$) (**Table 2**).

Most health-care workers provided positive feedback towards the VA telephone interview. Most female health-care workers felt comfortable (83.3%) and found it easy to convey complicated questions (80.6%), and health-care workers from rural areas (85.3%) also felt more comfortable with telephone interviews (**Table 3**).

Data quality

There were eight cases with unusable causes of death (10.8%) that were categorized as garbage codes. The comparison between cases with and without garbage codes showed no difference between the health-care workers' sex, locality, profession or interview experience (**Table 3**).

DISCUSSION

Face-to-face interview has been the standard method of communication for VA interviews.[1] This study shows that telephone interviews are a feasible alternative when face-to-face interviews are not possible, such as during a pandemic.[10] This finding aligns with multiple studies that have shown telephone interviews to be beneficial and comparable to traditional face-to-face interviews.[11,14–16] Telephone interviews in this study achieved a higher proportion of successful outcomes compared with a Malaysian study in 2013 of successful VA face-to-face

Table 1. **Characteristics of cases, health-care workers and telephone type by VA telephone interview outcomes (*N*=113)**

Characteristics	Telephone interview outcome		*P*
	Successful, *n* (%)	Unsuccessful, *n* (%)	
Total	74 (65.5)	39 (34.5)	
Cases			
Locality			
Urban	40 (67.8)	19 (32.2)	0.589
Rural	34 (63.0)	20 (37.0)	
Zone			
North-east	29 (80.6)	7 (19.4)	0.002
Central-south	26 (74.3)	9 (25.7)	
Borneo	19 (45.2)	23 (54.8)	
Health-care workers			
Sex			
Male	38 (63.3)	22 (36.7)	0.608
Female	36 (67.9)	17 (32.1)	
Profession			
Medical officer	34 (63.0)	20 (37.0)	0.589
Medical assistant or nurse	40 (67.8)	19 (32.2)	
VA interview experience			
≥12 interviews	42 (60.0)	28 (40.0)	0.118
<12 interviews	32 (74.4)	11 (25.6)	
Telephone type			
Office telephone	41 (66.1)	21 (33.9)	0.874
Personal telephone	33 (64.7)	18 (35.3)	

Table 2. **Caregiver characteristics by health-care worker assessment of caregiver VA telephone interview acceptability for interviews with successful outcomes (*N*=74)**

Caregiver characteristics	Health-care worker assessment of caregiver VA telephone interview acceptability								
	Trust towards health-care worker, *n* (%)			Questionnaire comprehension, *n* (%)			Interview cooperation, *n* (%)		
	Easy	Difficult	*P*	Easy	Difficult	*P*	Good	Poor	*P*
Total	64 (86.5)	10 (13.5)		65 (87.8)	9 (12.2)		71 (95.9)	3 (4.1)	
Sex									
Male	40 (81.6)	9 (18.4)	0.087	42 (85.7)	7 (14.3)	0.434	46 (93.9)	3 (6.1)	0.207
Female	24 (96.0)	1 (4.0)		23 (92.0)	2 (8.0)		25 (100.0)	0 (0.0)	
Age group									
18–39 years	21 (77.8)	6 (22.2)	0.195	26 (96.3)	1 (3.7)	0.018	26 (96.3)	1 (3.7)	0.820
40–59 years	36 (90.0)	4 (10.0)		35 (87.5)	5 (12.5)		38 (95.0)	2 (5.0)	
≥60 years	7 (100.0)	0 (0.0)		4 (57.1)	3 (42.9)		7 (100.0)	0 (0.0)	
Employment status									
White collar	17 (94.4)	1 (5.6)	0.321	18 (100.0)	0 (0.0)	0.154	18 (100.0)	0 (0.0)	0.602
Blue collar	29 (80.6)	7 (19.4)		31 (86.1)	5 (13.9)		34 (94.4)	2 (5.6)	
Unemployed	18 (90.0)	2 (10.0)		16 (80.0)	4 (20.0)		19 (95.0)	1 (5.0)	
Relationship									
Family	61 (85.9)	10 (14.1)	0.485	62 (87.3)	9 (12.7)	0.511	68 (95.8)	3 (4.2)	0.716
Non-family	3 (100.0)	0 (0.0)		3 (100.0)	0 (0.0)		3 (100.0)	0 (0.0)	

Table 3. **Health-care worker characteristics by health-care worker feedback on VA telephone interview and data quality of cause of death for interviews with successful outcomes (*N*=74)**

Health-care worker characteristics	Health-care worker feedback on VA telephone interview, n (%)									Data quality of cause of death, n (%)		
	Limitations of telephone interview			Comfort of telephone interview			Ability to convey complicated questions					
	No limitation	Encountered limitation	*P*	Comfortable	Not comfortable	*P*	Easy to convey	Difficult to convey	*P*	Non-garbage code	Garbage code	*P*
Total	56 (75.7)	18 (24.3)		53 (71.6)	21 (28.4)		50 (67.6)	24 (32.4)		66 (89.2)	8 (10.8)	
Sex												
Male	26 (68.4)	12 (31.6)	0.135	23 (60.5)	15 (39.5)	0.030	21 (55.3)	17 (44.7)	0.020	33 (86.8)	5 (13.2)	0.504
Female	30 (83.3)	6 (16.7)		30 (83.3)	6 (16.7)		29 (80.6)	7 (19.4)		33 (91.7)	3 (8.3)	
Locality												
Urban	31 (77.5)	9 (22.5)	0.692	24 (60.0)	16 (40.0)	0.016	26 (65.0)	14 (35.0)	0.609	36 (90.0)	4 (10.0)	0.808
Rural	25 (73.5)	9 (26.5)		29 (85.3)	5 (14.7)		24 (70.6)	10 (29.4)		30 (88.2)	4 (11.8)	
Profession												
Medical officer	27 (79.4)	7 (20.6)	0.490	27 (79.4)	7 (20.6)	0.171	26 (76.5)	8 (23.5)	0.131	30 (88.2)	4 (11.8)	0.808
Medical assistant or nurse	29 (72.5)	11 (27.5)		26 (65.0)	14 (35.0)		24 (60.0)	16 (40.0)		36 (90.0)	4 (10.0)	
VA interview experience												
≥12 interviews	32 (76.2)	10 (23.8)	0.906	28 (66.7)	14 (33.3)	0.279	29 (69.0)	13 (31.0)	0.755	38 (90.5)	4 (9.5)	0.683
<12 interviews	24 (75.0)	8 (25.0)		25 (78.1)	7 (21.9)		21 (65.6)	11 (34.4)		28 (87.5)	4 (12.5)	

interviews (65.5% compared with 53.1%).[2,17] That the interview outcomes were similar for both urban and rural localities suggests that telephone coverage is widely distributed across Malaysia, which may not be the case in other countries with lower urbanization levels.[18]

The telephone interviews for VA were acceptable in this study, with the health-care workers reporting that the interviewed caregivers showed trust, easily understood complicated questions and were cooperative throughout the interview process. Despite the presence of emotional conflicts when talking about a deceased family member, the caregivers trusted the health-care workers and were willing to complete the telephone interview.[19] This suggests that VA data collection is unaffected by the telephone method. The absence of obtrusive interviewer note-taking that is usually present during a face-to-face interview might have increased the focus and question comprehension of the caregiver being interviewed.[16]

This study did find that older caregivers encountered some difficulty in question comprehension, compared with other age groups. It is not surprising that older people had difficulties in question comprehension because this also occurs in face-to-face settings, especially for medically related questions.

Around two thirds of health-care workers provided positive feedback about conducting the VA by telephone interview. Both male and female health-care workers reported being comfortable with telephone interviews, with a higher proportion of females reporting being comfortable. This difference might be influenced by females having a lower preference for travelling and perceived interviewer safety during face-to-face interviews. Telephone interviewing reduces travelling and physical encounters with strangers outside the workplace area, which can be an issue for females.[15,16,20] Health-care workers from rural areas also reported being comfortable with telephone interviews, possibly due to time– and cost–effectiveness, because telephone calls make it easy to reach geographically distant caregivers in rural areas.[11,16]

Poorly collected data from a VA interview can influence a physician's decision when determining the cause of death and lead to an ill-defined underlying cause of death or garbage code. The loss of mortality data due to unusable garbage codes is likely to affect the data quality and accuracy of mortality surveillance.[21] In our telephone interview study, 10.8% of cases had garbage codes, an acceptable level when compared with the 30–35% garbage codes found from a local Malaysian study involving face-to-face VA interviews.[2] There was no difference in data quality by the health-care workers' specific professions and experience, suggesting that a telephone interview is easy to conduct and does not need specific skills or experience requirements.

This study highlighted a few problems with conducting VA interviews, regardless of the interview modality, such as incorrect or unavailable caregiver contact information.[17] A study on VA using face-to-face interviews also mentioned issues such as uncontactable caregivers due to change of address and incorrect caregiver contact information, which caused a delay in completing the interview process.[2,17] Delay between the death and the interview can make it difficult for caregivers to convey accurate information due to recall bias, especially if the delay is for more than 1 year.[22] Providing contact information for more than one caregiver in the civil registration system might be a potential solution for this persistent problem. Also, unanswered telephone calls, caregiver distrust and caregiver disagreement could be reduced by sending a formal letter or text message complete with organizational identification and contact information before the telephone calls to encourage people to respond to the call.[23]

The results from this study showed that, once a caregiver was contactable, 91% of VA interviews were successfully completed. This may be the first time the outcome of a VA telephone interview has been assessed. Participants were recruited from across all states to ensure equal distribution across the nation, and investigators were blinded from the selection of interviewers to avoid bias. Nevertheless, the study had some limitations, including a small sample size, the characteristics of unsuccessful interviews not being thoroughly investigated and the caregivers' feedback being only from the perspective of the health-care workers.

Overall, the study found that the telephone interview method is feasible and accepted by both caregivers and health-care workers and has an acceptable level of data quality. Using this method, Malaysia could improve the VA system by incorporating the use of software for faster data collection and algorithms for automated cause of death determination. Such innovations should be explored further in future studies for Malaysia.[24]

CONCLUSION

This study provides preliminary evidence that a VA telephone interview is feasible and can be used as an alternative to face-to-face interviews without affecting data quality or the flow of data collection. During pandemics or other instances where face-to-face interviews are not possible, the telephone interview method ensures VA data collection is not delayed and provides accuracy for mortality data in Malaysia. However, before policy decisions can be made regarding the routine use of telephone interviews, a large-scale study is recommended to yield more robust and comprehensive results to better evaluate the efficacy of telephone interviews compared with face-to-face interviews. Telephone interviews for VA should also be considered when there are transportation, geographical, time and cost limitations, and not just during the current pandemic. When feasible, these recommendations apply to other countries as well.

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Conflict of interest

None declared.

Ethics statement

Ethical approval for this study was obtained from the Medical Research and Ethics Committee, Ministry of Health Malaysia.

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The role of leadership among a Congolese community in Australia in response to the COVID-19 pandemic: a narrative study

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Objective: Community leadership enhances collective action in times of uncertainty, such as during the coronavirus disease (COVID-19) pandemic. This study explores the role of leadership related to the COVID-19 response and information sharing among a newly emerging Congolese community in the Hunter New England region of Australia.

Methods: Semi-structured qualitative inquiry was used to interview four participants who were identified as being influential leaders of the local Congolese community. The findings of this study were part of a larger exploration of COVID-19 messaging among emerging culturally and linguistically diverse (CALD) communities. Two interviewers independently analysed the transcribed data before pairing their findings. Narrative analysis was employed.

Results: Two major themes were identified: leadership as an assigned and trusted role, and leadership as a continuous responsibility. Several categories were identified within these themes, such as mutual connection, education level, multilingual ability and networking.

Discussion: The Congolese community leaders reported feeling responsible and confident in their ability to proactively contribute to the local COVID-19 response by enhancing communication within the community. By partnering with and learning from respected leaders in CALD communities, government health services have the opportunity to improve how current public health messaging is developed.

In Australia, collaboration with leaders of culturally and linguistically diverse (CALD) communities has been recommended for communication of coronavirus disease 2019 (COVID-19) health information, particularly around vaccination.[1,2] Many refugee communities are tightly knit and rely on advice and guidance from community leaders.[3]

Congolese immigrants are a newly emerging population in regions of Australia, such as the Hunter New England area, with most coming to Australia as humanitarian arrivals. Refugees from the Democratic Republic of the Congo have been subject to human rights violations related to the country's history of intermittent armed conflict and political unrest.[4,5] Most refugees from the Democratic Republic of the Congo crossing the border reach rural settlements or camps in neighbouring Burundi, Rwanda, Tanzania and Uganda, where work and educational opportunities are limited.[5] Additionally, basic humanitarian needs have been further compromised by multiple Ebola virus disease outbreaks since 2018.[4] Many Congolese are multilingual, but it is estimated that less than 50% of Congolese refugees speak English, and only 10% report the ability to read and write English well.[5]

By listening to community leaders, we explored and gained insights into the concept of leadership among a newly emerging Congolese population in Australia, and how leadership is being enacted during the COVID-19 response. No similar work has been reported in Australia or internationally.

METHODS

Four participants of Congolese or Burundian background were recruited by purposive sampling among community leaders, after initial recommendation by a local refugee health nurse. The participants took part in semi-structured interviews as part of a larger project. Three participants were interviewed together and one individually.

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Researchers from the Multicultural Health and Refugee Health Service (MHRHS) conducted the interviews in English, exploring participants' roles in relation to COVID-19 information sharing. "Community" was defined as "recently arrived refugee immigrants who identified as having Democratic Republic of the Congo heritage, living in the Hunter New England region". Participants often chose to broaden this term to include refugees of Central African background living locally. "Leadership" was ascertained by participants themselves. All four participants self-reported being leaders in their community, and this was corroborated by the other participants.

The Congolese have a strong oral tradition that values storytelling as a way of making sense of the world and conveying knowledge.[6] Narrative analysis was employed to interpret the roles and experiences through stories.[7] Two researchers analysed the data individually before combining to create a paired analysis for each transcript. Researchers focused on the content of the stories and how the narrator organized information to convey meaning.[8] Similar concepts were grouped into categories, forming two overarching themes.

RESULTS

The participants comprised three women and one man, aged between 20 and 60 years. All could read, write and speak both Swahili and English, and several minority languages. Three participants provided additional information, reporting lived experiences as a refugee, attainment of tertiary education and holding employment positions in Australia that were external to their roles with the African community.

Each participant shared stories using a similar structure, where the main point was given first and then explained. The participants circled back to their main points for emphasis and spoke confidently of community and culture.

The narrative structure and the content of the participants' narratives revealed two aspects of leadership in this resettled Congolese community – that it is a socially assigned and trusted role, and it carries an ongoing responsibility.

Leadership as a socially assigned and trusted role

Participants told stories of leadership as a role bestowed by community members and of how that role was respected by work colleagues outside the community (**Table 1**). They reported that the community's perceptions about education level empowered a leader who could research and provide accurate advice and information. Education boosted participants' self-confidence, as one described: "I'm not the expert, but my level of education allows me to go seek the right level of education [information] that I can also spread". Being multilingual was advantageous in navigating and understanding media resources in English and other languages, and it provided participants with additional leverage to inquire, interpret and explain COVID-19 information.

Mutual cultural understanding, sharing common languages and connection with the community were described by participants as factors contributing to trust and connectivity. One participant explained: "I share the same cultural background as community members, like people from Burundi, and those that speak the languages I use … having supported different people and built trust from the community, it's from mutual understanding and the relationship that makes me play a key role". Being trusted by the community strengthened the participants' confidence to be leaders. One participant explained: "According to that trust, I feel free to interact with people who ask to know something".

Leadership as a continuous responsibility

The responsibility of leadership was seen as continual: one participant described "leading the community in our regular gathering", and another explained that "we usually talk nearly every single day and pass what we have heard in the news in our local languages". Participants reported carrying various leadership responsibilities in ways that were caring and respectful; this was displayed through words such as "encourage", "help", "tell", "contribute", "share", "benefit" and "connect".

Participants reported how they carried out their leadership responsibilities and mobilized to help com-

Table 1. **Evidence supporting theme: Leadership as a socially assigned and trusted role**

Leadership as a socially assigned and trusted role	Participants' quotes
Role bestowed by others	Yeah, the day I went to drop my CV and we talking and they say well we know you are a leader, and this is the refugee from there and we know that you help them, so we know you will help us as well ... And we work together.
Importance of education and English language skills	The educational background I have back home and here, it added up to people to trust me, people to ask me things … and also the capacity of advocating on their behalf to gain the trust in the community, and also have something to contribute. [Community members] contact me because they believe, as a leader, that I have done more research … so they just want to double check, because [for] some [of them] English language may still be low.
Shared language and culture	So it's just mutual connection, network, one-to-one talk, that helps channel information, and update one another. So most times, people would call and say "we heard about this" and ask "how much more did you hear about this"? And then you have to go through it and explain in a language they understand. Because most of us, we share … the same language and background, so it's an easy task to explain in their local language or in a language they understand better.
Relationship with trust	I strongly believe that my role as a community connector, and also the trust the community has in me, has impacted me to do everything that I can offer to the community.

Table 2. **Evidence supporting theme: Leadership as a continuous responsibility**

Leadership as a continuous responsibility	Participants' quotes
Responsibility as an ongoing phenomenon	Since I came ..., I have good relationship with my Congolese community and also African community around ... over 10 years to get to know each other, and also to win trust from the community, because we are here to help each other. Wherever help is needed, when I can respond to, I do that's how … even when an issue arises, it's easy to interact … the same way of sharing information about COVID.
Responsibility to act	Then we come out with the idea, ok, let us translate. I did the translation in Swahili, then I post on my WhatsApp, then I say ok … just send me inbox and I will send you to read, the safety … about what the meaning of COVID, what you must do, how you going to wash your hands, that stuff like that, the basic stuff. You see, we have that burden of getting people to know what is happening, especially about COVID, because there is also a lot of misinformation. So when we get together, or when we have the opportunity to meet with someone, is trying to fix the information that they got that is not right.
Responsibilty to share accurate information	If we come across something that is related to COVID, before you send it out there, you have to do a little bit of research. So you check the correct source – the government, and if it's something you heard from social media, if you compare it to what the government has is the same, that's when you get that and post it on the status or post it on the WhatsApp. So we need to ask questions, and so we can have answers to those question and be confident with whatever we are saying.
Responsibility to incorporate network	And also the different work, different jobs I do … all this gives me the position and strength to share what I have to contribute to building the community strength.

munities (**Table 2**). For example, by interpreting and translating key public health messages and pitching them in ways that were understood by community members. One participant reflected: "Most of us, we share the same language and background, so it's an easy task to explain in their local language or in a language they understand".

Participants described proactively using platforms familiar to community members (e.g. WhatsApp). For example, participants called community members during lockdown periods, translated and voice-recorded COVID-19 information and uploaded audio-links to share on social media. One participant explained that their response to act swiftly and dispel misinformation was in part "because as a community leader, my heart is to see people working within the regulation".

Participants also took responsibility by passing on information to community members only after validating the information. One participant explained: "I like my source to be accurate; before spreading any information, I need to check the government and health website. That way I know".

Lastly, participants described how networking opportunities allowed COVID-19 information gained from their workplaces to benefit their community. One participant described the strength of their network in this way: "My tentacles reaches [sic] everywhere. So, in terms of getting useful information, it can come from anywhere".

DISCUSSION

There is strong evidence supporting CALD leader engagement in health care,[1,2] but little is known about how community leadership is recognized and developed. Some insights have emerged from this work where participants have become community leaders through social processes and recognition. Commonality of culture and language were reported to be strong contributors to the community's perception and trust of the participants as leaders. During the COVID-19 pandemic in particular, being strong English speakers afforded our participants opportunities to network across African and non-African spaces, enhancing the flow of important public health messages. As described by the United Nations High Commissioner for Refugees, higher-level education turns students into leaders.[9]

The leadership role entrusted to the participants also brought ongoing responsibility and accountability. Participants reported performing leadership roles by seeking out and conveying accurate COVID-19 information to the community in ways that were understood by the community.

Similarly, in the Ebola response, community engagement by health services that actively partnered with respected leaders and other community mobilizers was critical to success.[10] During Ebola outbreaks in Central Africa, members of communities bordering other countries trusted local leaders, not government health workers, as a source of information about Ebola. Similarly, the Congolese community in Australia has strong trust in community leaders. Thus, public health solutions should be tailored to communities by listening to and learning from community leaders.[11] Furthermore, the Ebola epidemic showed that a shift from the biomedical model for outbreak response towards a more holistic sociobehavioural model is necessary for policy-makers to achieve collective cooperation.[12] Such frameworks have been recommended for the COVID-19 pandemic response worldwide.[10,12]

The thoughtful engagement of Congolese community leaders has also been described in management of sensitive issues such as sexual and reproductive health.[13] Community leaders in the Democratic Republic of the Congo hold strong influence over the community's perception of sexual health, accessing of services, stigma and cultural taboos.[13] By engaging community leaders respectfully with two-way discussions, leaders could become advocates for sensitive health issues within their community.[13] Respectful collaboration with community leaders allows public health messages to reach and be received by CALD community members in a timely and meaningful way.

The World Health Organization's COVID-19 global risk communication and community engagement strategy notes that community-centred participatory approaches provide opportunities for governments to support otherwise unreachable marginalized groups.[10,14] This is done by identifying and collaborating with community leaders, to co-design and coordinate public health responses that are acceptable to the community.[10,12]

The Congolese community is diverse: the stories and experiences of the four English-speaking leaders interviewed may not represent other leaders in the Hunter New England region and beyond, particularly those with limited English ability. The sociocultural context of communities may also impact the relationship between communities, leaders and governments, especially in settings of rapid change such as this pandemic; hence, governments need to be flexible and engaged. The lead MHRHS researchers are themselves of a CALD background. Therefore, particular stories and focus may have been drawn from the participants, bringing strength and opportunities for deeper conversation. The small number in this study suited the approach of narrative analysis – exploring the contextual stories and opinions of participants interviewed – but is a limitation.

The COVID-19 pandemic has precipitated responses from community leaders to fill a void in public health communication messaging. The Congolese community in this study had access to people who were socially assigned and given responsibilities as leaders. These individuals were educated and multilingual, and had collaborative abilities and common cultural experiences.

By nurturing two-way communication, government health services can learn and improve upon current methods of COVID-19 messaging to reach CALD communities, to further reduce risks to communities. The public health response in a pandemic should be underpinned by partnerships with leaders to reach common goals. Further studies on leadership and engagement with CALD communities are essential.

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Conflicts of interest

The authors are salaried employees of Hunter New England Health, under the New South Wales Ministry of Health.

Ethics statement

This study received approval from the Hunter New England Human Research Ethics Committee (approval no. 2020/ETH02955).

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Comparison of strategies for daily surveillance of international travellers quarantined in Vanuatu, October–December 2020

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Objective: To prevent importation of coronavirus disease 2019 (COVID-19) to Vanuatu, since March 2020, all travellers to the country have been required to complete a 14-day quarantine in a government-designated facility. A short message service (SMS, or "text message") system was developed to collect information on symptoms of COVID-19 among travellers in quarantine. A trial within a cohort study was conducted among travellers arriving to Vanuatu by air from 27 October to 7 December 2020 to assess SMS acceptability, efficiency and utility and whether SMS-based health monitoring was as effective as in-person monitoring in identifying people with COVID-19 symptoms.

Methods: Control group participants received standard monitoring (daily in-person visits) and participants in the intervention group received a daily SMS text requesting a response coded for symptom development. Differences between the two groups were determined using χ^2 tests.

Results: Of the 495 eligible travellers, 423 participated; 170 were allocated to the control group and 253 to the intervention group. At least one return SMS text was received from 50% (107/212) of participants who were confirmed to have received an SMS text. Less than 2% (4/253) of the intervention group and 0% of the control group reported symptoms.

Discussion: The SMS intervention had a high level of acceptability. SMS is a useful tool to monitor symptom development among people in quarantine and for broader public health programmes that require follow up.

Since March 2020, the Government of Vanuatu (a group of 83 islands with a population of approximately 302 000) has implemented several measures to prevent the importation and community transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the pathogen that causes coronavirus disease 2019 (COVID-19). Measures include quarantining incoming travellers and suspending international ports of entry into Vanuatu.[1] Between May and December 2020, 4661 people returned to Vanuatu through a repatriation programme. Implementing quarantine and monitoring the symptoms of those in quarantine added a considerable burden to the public health system in Shefa Province where the capital city, Port Vila, is located. Public health and nursing staff were redeployed from community-based health services within Shefa and from other provincial health services, resulting in the closure of health centres or delays in providing some essential health services. The impact of these closures and delays has not been quantified.

To address the issue of limited health resources and high demand on public health resources due to these quarantine requirements, Shefa Provincial Health Service and the Vanuatu Ministry of Health (MoH) considered alternative strategies for monitoring the health of asymptomatic people in quarantine, such as using short message service (SMS, or "text message") technology. SMS technology has been effectively used

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in a variety of public health programmes aiming to control infectious diseases; for example, SMS has been used to send reminders for infant vaccinations,[2,3] to send treatment reminders to improve adherence to HIV pre-exposure prophylaxis[4] and tuberculosis treatment,[5] and to send partner notifications for contact tracing for sexually transmitted infections.[6] Limited studies have used SMS texts to record two-way information flow (that is, responses to questions that are recorded within the SMS), and none of these has been from a Pacific island country. For example, an intervention in Western Australia used SMS to monitor the health of people who had recently travelled to areas in Africa affected by Ebola virus disease.[7] In that intervention, people were sent an SMS text twice daily for 3 weeks requesting their temperature and information about symptoms. If any related symptoms were reported, a medical officer contacted the person and followed up as appropriate.

The present study sought to develop and assess an SMS-based system to streamline active monitoring of travellers returning to Vanuatu. The objective of the study was to assess SMS acceptability, efficiency and utility and whether SMS-based health monitoring was as effective as in-person monitoring to identify people with symptoms of COVID-19 in Vanuatu.

METHODS

Study design

This operational research used a trial within a cohort. The cohort was inbound travellers to Vanuatu who arrived by air between 27 October and 7 December 2020.

Inclusion and exclusion criteria

Individuals aged ≥18 years arriving from a country classified as low risk were eligible to participate. Low-risk countries were defined by the Vanuatu MoH and included those with a 14-day incidence of <10 newly reported cases/100 000 population that had direct flights to Vanuatu and had no reported community transmission. Individuals with pre-existing respiratory conditions or health issues were identified through review of pre-travel registration forms, as per standard processes, and were excluded from the study.

Recruitment and consent

A research nurse obtained written consent from participants after they arrived at their hotel; consent forms were translated into both English and Bislama (one of the official languages of Vanuatu).

Infection prevention and control measures

The research nurse wore personal protective equipment based on World Health Organization (WHO) recommendations for health-care workers.[8] Where possible, the research nurse contacted eligible participants by phone. Consent forms were collected by the research nurse and stored in a file for 3 days before being accessed.

Control and intervention groups

In the control group, participants received standard monitoring. This involved daily visits from public health teams. Monitoring teams worked in pairs, with one member recording data and the other conducting the assessment. The assessment included a temperature check using a digital thermometer and enquiries about symptoms such as fever, cough, sore throat or related symptoms. The results were recorded in a paper record that was stored at Shefa Provincial Health Service before the data were entered into the quarantine database (a customized Google Sheets database with restricted access).

Participants with symptoms were followed up by a rapid response team. If asymptomatic, people in quarantine were tested on days 5 and 11 after arrival, and if symptomatic, they were tested on the day of symptom onset. Laboratory testing was conducted using the Xpert Xpress SARS-CoV-2 cartridge assay (Cepheid, Sunnyvale, CA, USA). Data on medical follow up and outcomes (including testing and associated results) were not included in the quarantine database and were stored in the District Health Information Software Version 2 (DHIS2) COVID-19 case-based surveillance module.

Participants in the intervention group were monitored only by SMS. Participants without a local mobile telephone number were provided with a local SIM card and were requested to activate the card. During the quarantine period, each day at approximately 09:00, an SMS text was sent to the person in quarantine: “In the last 24 hours, have you experienced a fever, cough or shortness of breath? If no, reply 1. If yes, reply 2.”

The returned SMS data were stored in a cloud-based database managed by Digicel Vanuatu (a mobile phone service provider) and accessible to the MoH. Data were downloaded as Microsoft Excel files and linked to the research database monitored by the Ministry. If symptoms were reported, the database automatically generated an alert that was sent to a public health officer. The officer then telephoned the individual to verify symptoms and confirm their location. If the symptoms met the COVID-19 case definition (based on the WHO case definition),[9] the Shefa provincial public health manager was informed, and the provincial rapid response team, comprising a medical practitioner and public health officer, was activated. Data on medical follow up and outcomes (including testing and associated results) were not included in the quarantine database and were stored in the DHIS2 COVID-19 case-based surveillance module. Participants in the intervention group were also tested on days 5 and 11 after arrival, as per the processes described above.

Sample size and allocation

The sample size required to have sufficient power to detect 5% of the population reporting fever, cough or shortness of breath with a design effect of 2 was 540. All arrivals reporting travel from an eligible location were recruited until the sample size was reached. Participants were block-allocated to either the control or intervention group according to date of arrival and hotel of allocation. Block randomization was used to ensure that all participants in the control group were quarantined in the same hotel, therefore reducing strain on the public health workforce by reducing their need to travel between multiple hotels.

Data collected

Relevant data were extracted from the quarantine database for participants in the control and intervention groups, including name, date of birth, port of departure and date of arrival in Vanuatu, and these were transferred to the research database (a customized Microsoft Excel database) and stored in a secure folder. The research database included additional data about participants in the intervention group including whether an outbound SMS text was sent by the Vanuatu MoH (yes/no) and the date, whether an inbound SMS text was received by the Vanuatu MoH (yes/no), the contents of the SMS response (1 = no symptoms, 2 = symptoms), whether a SARS-CoV-2 test was requested (yes/no) and the results of the test. In addition, on the final day prior to release from quarantine, a five-question paper-based survey was distributed to all participants in the intervention group to assess the acceptability of the SMS monitoring system.

Data analysis

χ^2 tests were used to compare: (1) characteristics of participants versus non-participants, (2) characteristics of the intervention group versus control group, (3) response rates of the intervention group by demographic variables and (4) symptoms reported in the intervention group versus control group. A P value of <0.05 was considered statistically significant. Stata Standard Edition software (version 15; College Station, TX, USA) was used for statistical analyses.

RESULTS

Participation rates

The last inbound flight to Vanuatu for 2020 occurred on 7 December 2020, and therefore the target sample size of 540 participants could not be reached. However, among 495 people eligible to participate, 423 consented (participation rate of 85%).

There was no statistical difference in proportions among participants and non-participants by sex and nationality, but more participants were aged 18–40 years compared with non-participants (P = 0.002). These proportions reflect the people travelling to Vanuatu at that time. Three quarters (78.0%; 330/423) of participants were male, one quarter (26.2%; 111/423) was aged ≥40 years and nearly all (95.0%; 402/423) were Vanuatu nationals. The nationalities of the 21 people who were not Vanuatu citizens included Australian (n = 13), French (n = 6), Chinese (n = 1) and Fijian (n = 1).

Description of intervention and control groups

Among the 423 participants, 170 (40.2%) were allocated to the control group and 253 (59.8%) to the intervention group. The control and intervention groups had similar distributions among age group and nationality; however, fewer males were in the control group (71.8% [122] versus 82.2% [208], $P = 0.011$) (**Table 1**).

Intervention response rate

Among the 253 participants in the intervention group, evidence that an SMS was received by the participant was available for 212 participants (83.8%). The reason why an SMS text was not received is unclear, but is likely due to non-registration of the SIM card or another technical issue. Among these 212 participants, at least one return SMS text was received from a total of 107 participants (50.4%). There was no statistical difference ($P > 0.05$) in sex, age group or nationality for participants in terms of the number of responses received (**Table 2**). The response rate varied for the first 3 days by sex, but ranged between 35% and 50% for all participants each day between day 4 and day 14 (data not shown).

Intervention impact

Overall, four people in the intervention group (1.6%) and none in the control group reported symptoms during the quarantine period; the difference was not statistically significant. All four people who reported symptoms received a SARS-CoV-2 test, and none were positive.

Evaluation of the intervention

The post-intervention evaluation was completed by 92 of the 253 participants in the intervention group (36.3%). Among respondents to the evaluation, 32 (34.8%) were female and 60 (65.2%) were male. The majority of females (27; 84.4%) and males (35; 58.3%) agreed that the instructions were easy to follow (**Table 3**). The majority of females (18; 56.3%) disagreed with the statement that responding by SMS was hard, while the majority of males (32; 53.3%) were neutral about the statement. The majority of females (19; 59.4%) and males (35; 58.3%) agreed that they were comfortable answering the questions.

Reasons for not responding included not activating the SIM card (females: 2, 6.3%; males: 3, 5.0%), having technical issues (females: 2, 6.3%; males: 4, 6.7%) and other reasons (not further described; females: 8, 25.0%; males: 6, 10.0%).

DISCUSSION

The detection rate of acute respiratory illness was higher for the intervention group than for the control group. However, it should be noted that the number of people reporting symptoms was low in both groups and is not statistically significant. Globally, there has been a decrease in respiratory specimens testing positive for influenza at sentinel surveillance sites.[10] This has also been reported in Vanuatu.[11] It is difficult to determine whether the overall low rate of symptom detection reflects underreporting in both the control and intervention groups. In contrast, in 2021 a new model for quarantine monitoring was adopted by the Vanuatu MoH whereby people in quarantine are telephoned to enquire about symptom development at two points during quarantine. From 1 January to 31 May 2021, 1226 people completed quarantine, among whom 5 (0.40%) reported influenza-like illness. This suggests that the SMS intervention may achieve a higher rate of reporting; however, further research is required.

There were several operational issues related to the use of SMS texts in Vanuatu, including challenges to ensuring that the SMS texts sent were received by participants. Reasons why texts were not received include people not activating the SIM cards and the use of an overseas-based bulk SMS service to send the SMS texts. During the post-intervention survey, people who did not respond to the SMS texts indicated that they forgot, had technical issues or did not understand the instructions. Translating the SMS text to Bislama may increase response rates, and the remaining barriers could all potentially be addressed through improved troubleshooting of communication and technology issues. It is unclear whether literacy rates contributed to successful reporting.

Overall, most participants reported that the intervention instructions were easy to follow and they were comfortable responding by SMS. However, a higher proportion of males than females found reporting by SMS to be difficult. This conflicts with the finding that the majority of females and males found the instructions easy to follow, so the challenges in responding by SMS may be due to technical or logistical issues associated with responding by SMS rather than understanding the instructions.

Table 1. **Characteristics of participants**

Characteristic	No. (%) of participants		P^a
	Control group	Intervention group	
Total	170 (40.2)	253 (59.8)	
Sex			
Female	48 (28.2)	45 (17.8)	0.011
Male	122 (71.8)	208 (82.2)	
Age group (years)			
18–40	119 (70.0)	193 (76.3)	>0.05
>40	51 (30.0)	60 (23.7)	
Nationality			
Vanuatu	159 (93.5)	243 (96.0)	>0.05
Other	11 (6.5)	10 (4.0)	

[a] χ^2 tests were used to compare the characteristics of the intervention group with those of the control group. $P < 0.05$ was considered statistically significant.

Our results suggest that both SMS and phone monitoring are acceptable methods, but that sufficient systems to identify and troubleshoot technological issues are required. In addition, our findings suggest that the use of one-way SMS rather than two-way (that is, communicating information by SMS without requiring a response) may be successful.

There are some additional limitations to consider. First, the sample size of 540 participants could not be reached and, as a result, the study has reduced statistical power to compare the control and intervention groups. However, we note that the broader objectives of the study were to evaluate the acceptability, efficiency and utility of SMS-based health monitoring, and the study was able to meet this objective. Second, it was not possible to validate whether travellers in the intervention group were truly asymptomatic as opposed to those in the control group; however, participants in the intervention group each had a specimen tested for SARS-CoV-2, and all results were negative. Third, the response rate to the evaluation among participants was low (31%) and, therefore, may not reflect the attitudes of all participants. However, some important findings about ways to improve response rates by SMS in the future were identified.

CONCLUSIONS

The findings of this research highlight that SMS is a useful tool to monitor symptom development among people in quarantine and that the intervention was both easy to understand and acceptable. The intervention achieved a 50% response rate, despite some technical difficulties.

Table 2. **Characteristics of the 212/253 people in the intervention group for whom there was evidence that an SMS (short message service) text was received requesting information about their symptoms**

Characteristic	No. (%) of intervention participants			P^a
	No SMS returned	1–5 SMS returned	>5 SMS returned	
Total	105 (49.5)	52 (24.5)	55 (25.9)	
Sex				
Female	12 (11.4)	13 (25.0)	9 (16.4)	>0.05
Male	93 (88.6)	39 (75.0)	46 (83.6)	
Age group (years)				
18–40	75 (71.4)	40 (76.9)	45 (81.8)	>0.05
>40	30 (28.6)	12 (23.1)	10 (18.2)	
Nationality				
Vanuatu	2 (1.9)	1 (1.9)	5 (9.1)	>0.05
Other	103 (98.1)	51 (98.1)	50 (90.9)	

[a] χ^2 tests were used to compare the response rates of the intervention group by demographic variable.

Table 3. **Responses to post-intervention evaluation by 92/253 participants in the intervention group**

Evaluation category	No. (%) of intervention participants	
	Female (n = 32)	Male (n = 60)
Ease and acceptability of the intervention		
Instructions were easy to follow		
Agree	27 (84.4)	35 (58.3)
Neutral	4 (12.5)	21 (35.0)
Disagree	1 (3.1)	2 (3.3)
Missing	0 (0.0)	2 (3.3)
Responding was hard		
Agree	2 (6.3)	11 (18.3)
Neutral	10 (31.3)	32 (53.3)
Disagree	18 (56.3)	12 (20.0)
Missing	2 (6.3)	5 (8.3)
I felt comfortable answering the questions		
Agree	19 (59.4)	35 (58.3)
Neutral	8 (25.0)	21 (35.0)
Disagree	4 (12.5)	2 (3.3)
Missing	1 (3.1)	2 (3.3)
Reason for not responding		
I had technical issues	2 (6.3)	4 (6.7)
I did not receive any messages	1 (3.1)	6 (10.0)
I did not understand the instructions	0 (0.0)	15 (25.0)
I did not activate the SIM card	2 (6.3)	3 (5.0)
I forgot	1 (3.1)	9 (15.0)
Other	8 (25.0)	6 (10.0)
Missing	18 (56.3)	17 (28.3)

The findings show that SMS is not inferior to in-person symptom detection and may be more effective than other methods, such as telephone calls. These findings have implications for COVID-19 responses in resource-limited settings as well as relevance to broader public health programmes that require follow up.

Ethics statement

Ethical approval was obtained from the Vanuatu Ministry of Health Ethics and Research Committee (6 October 2020) and the University of Melbourne Human Research Ethics Committee (number 2057578.1). All participants received 1000 vatu (approximately US$ 9.20) of phone credit from Digicel Vanuatu at the completion of the study.

Conflicts of interest

Caroline van Gemert holds an Early Career Research Fellowship, funded by the Australian National Health and Medical Research Council. The other authors declare they have no conflicts of interest.

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Fieldwork for public health responses during pandemics: lessons from the New South Wales Health experience with COVID-19

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Problem: Fieldwork is a vital component of public health emergency response, yet little has been published on undertaking fieldwork safely. Safety is of particular importance with emerging pandemic viruses, which can pose additional risks to public health fieldwork staff.

Context: During a pandemic, surge health staff may be drawn from diverse professional backgrounds; they may have limited experience in fieldwork or be unfamiliar with the risks posed by a novel virus. Novel pathogens pose dangers to fieldwork staff, particularly when there are global or local shortages of personal protective equipment.

Action: During the coronavirus disease 2019 (COVID-19) pandemic, New South Wales (NSW) Health's Public Health Emergency Operations Centre (PHEOC) deployed staff for fieldwork in a range of settings. The PHEOC developed a protocol to systematize planning, risk assessment and management for COVID-19 fieldwork. The protocol was accompanied by training, discussion exercises and debriefs to support PHEOC fieldwork staff.

Lessons learned: Effective fieldwork is an essential component of outbreak investigation and management, including stakeholder management. Here, we share and discuss key elements of the NSW Health protocol to support fieldwork during outbreak responses for emerging communicable diseases across various resource contexts. Limited understanding of novel viruses, particularly in the early phases of a pandemic, must be considered in decisions to deploy fieldwork staff and implement precautionary risk mitigation approaches. Planning is essential to protect staff and ensure ethical allocation of resources. Through appropriate selection of teams and training, surge staff can be supported to effectively conduct fieldwork.

PROBLEM

Public health responses to outbreaks can involve fieldwork to support outbreak investigation and implementation of control measures (where "fieldwork" means deploying staff to outbreak sites to support the public health response). Fieldwork is common in public health, yet little has been published on how to safely conduct it. The emergence and spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus responsible for coronavirus disease 2019 (COVID-19), highlights the challenges posed by novel viruses for public health authorities coordinating fieldwork. Public health practitioners are a vital but scarce resource during pandemic response. Beyond workplace obligations, an effective public health response must assess, mitigate and control occupational exposure of fieldwork staff. Failure to achieve this can place staff and the community at risk of infection, with potentially serious consequences.

Fieldwork can be particularly difficult when responding to a condition for which there is an evolving knowledge base. Our understanding of SARS-CoV-2 transmission has changed rapidly over the course of the pandemic (e.g. changing definitions for cases and close contacts of COVID-19 in Australia's national guidelines).[1] The possibility of asymptomatic and pre-symptomatic transmission and the broad range of clinical symptoms[2] can lead to retrospective recognition of infectious exposures during fieldwork, given that new cases may be identified after symptoms develop or following broader testing.

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Here, we present learnings from the development of the New South Wales (NSW) Health protocol: *Preparing for COVID-19 fieldwork: protocol for PHEOC staff* (hereafter, the protocol) and share its framework and checklists to support risk management for other jurisdictions. The protocol was developed for COVID-19 fieldwork in NSW, but we believe this approach can be readily adapted for application to other infectious diseases and resource contexts.

CONTEXT

Responsibility for coordinating fieldwork to support public health investigations and responses during the COVID-19 pandemic lay with the NSW Ministry of Health's Public Health Emergency Operations Centre (PHEOC) and the public health units (PHUs) of local health districts. At NSW Health, public health fieldwork is typically undertaken by PHUs. Fieldwork supports investigations of infectious disease outbreaks and environmental exposures, implementation of public health management and coordination of response management. However, in the context of a novel virus, there were specific challenges:

- Pandemic responses often involve surge staff, who may have limited public health or fieldwork experience.[3]
- Experienced public health staff may be unfamiliar with the risks posed by a new virus and the specific infection prevention and control (IPC) procedures required, such as personal protective equipment (PPE).[4] Although PPE training is routinely provided as part of orientation for new employees in Australian health systems, less than half of surveyed providers report annual or regular refresher training.[5] For non-clinical public health staff, there may be even fewer opportunities for routine IPC training.
- The pandemic context typically requires urgent decision-making and rapid responses, potentially against a background of an overwhelmed health system and resource scarcity that presents ethical challenges.[6]

ACTION

During the NSW Health COVID-19 pandemic response, the PHEOC's operations team undertook fieldwork in various settings, including residential aged-care facilities, schools, cruise ships, workplaces, airports and hotels. Each setting required relationship building through consultation with different stakeholders. Fieldwork activities included site assessment to consider potential transmission dynamics and to inform contact tracing; screening to identify individuals at risk of COVID-19; collection of samples for SARS-CoV-2 testing; and IPC assessments. Often, fieldwork staff were also required to provide immediate public health advice, support outbreak management decisions and communicate with stakeholders (both onsite and offsite). Decisions to deploy staff for fieldwork were generally required urgently, typically within 1–12 hours.

The PHEOC iteratively developed the protocol to guide and support fieldwork teams as understanding of SARS-CoV-2 evolved. For example, when the protocol was first drafted, it was not clear whether asymptomatic transmission was possible or was a key driver of transmission. Once such transmission was recognized, we strengthened the protocol's approach to IPC accordingly. Issues identified from fieldwork deployment debriefs were used (with reference to the NSW Health risk management policy)[7] to develop and test the protocol with fieldwork staff, to ensure that solutions were pragmatic and realistic. Thus, the protocol was repeatedly piloted, tested and revised, and drew on the lived experiences of deployed staff. Additionally, the PHEOC operations team facilitated fieldwork training for surge staff, including tabletop discussion exercises, after which the protocol and field kits stocked for deployments were further improved and incorporated into an equipment checklist (**Fig. 1**).

Incorporating IPC measures was identified as a vital component of risk mitigation, along with the recognition of insufficient capacity within the PHEOC to provide IPC training. IPC experts and clinical nurse consultants from the NSW Government's Clinical Excellence Commission (CEC) were engaged to provide IPC training and assessment to surge staff. The CEC produced guidelines for IPC in clinical settings in NSW Health,[4] and their staff directly supported PHEOC's public health fieldwork activities, including onsite IPC assessments. The CEC delivered tailored IPC training, including certification for fieldwork staff in safe use of PPE requirements for COVID-19 (standard, contact, droplet and aerosol precautions)[8] and practical guidance on identifying and managing breaches of PPE, and the establishment of field donning and doffing stations.

Fig. 1. **Equipment checklist and standard kit contents, NSW Health**

Equipment checklist	
☐	Field kit backpack. Contents should be personalised to individual staff. Standard kit contents can be viewed in the table below
☐	Swabs (number of swabs required will depend on number of patients)
☐	Pathology request forms
☐	NSW Health ID (and Human Biosecurity Officer ID, if required)
☐	Paperwork (e.g. public health orders, revocation letters)
☐	Mobile phone (PHEOC phones are available)
☐	Fleet car satchel & keys and/or cab charges
☐	Laptop and charger (If required. All staff should ensure their laptops are set up to work remotely before being deployed on fieldwork.)
☐	SIM card for laptop if required

Item	Quantity
Swabs	Varies
Sample collection bags	Varies
Pathology request forms	Varies
Thermometer	1
Thermometer covers	200 (1 box)
Spare batteries	4 (AA)
Hand sanitizer 375 ml	1
Hand sanitizer 60 ml	3
Surgical mask	1 box (50 units)
P2 mask	5
Safety spectacles	2
Face shield	3
Gown	5
Gloves (small)	12 (6 pairs)
Gloves (medium)	12 (6 pairs)
Gloves (large)	12 (6 pairs)
Alcohol wipes	1 canister
Clinnell wipes	1 packet
Yellow waste bags	5

Developing the protocol highlighted the importance of preparation, risk assessment and team briefings before fieldwork activities, systematized by the development of an action checklist (**Fig. 2**). A key question posed during the risk assessment process was whether there were any effective alternatives to undertaking fieldwork that would minimize risks to staff (e.g. videoconferencing, using resources such as maps of facilities or using a risk assessment tool). Likewise, the opportunities for other staff to learn from the experiences of fieldwork staff and to make further improvements to the protocol were formalized through the development of a structured debrief document (**Fig. 3**).

LESSONS LEARNED

In our experience, effective fieldwork can confer benefits beyond the investigative information gathered in the field to guide outbreak response efforts. Importantly, fieldwork plays a crucial role in establishing cooperative relationships with staff at facilities and organizations, which are integral components of successful outbreak management. For example, some residential aged-care facilities experienced a significant increase in workload during outbreaks, with reduced staff, increased IPC requirements, increased reporting demands and media attention. In such cases, fieldwork staff were able to

Fig. 2. **Checklist of key actions to support fieldwork deployment, NSW Health**

Action		Owner
Prior to field departure or 1–3 days before fieldwork		
☐	Conduct risk assessment of fieldwork in consultation with relevant staff members	Operations
☐	Identify authorised medical practitioners or clinical staff to undertake fieldwork	Operations
☐	Identify administrative support staff to undertake fieldwork	Operations
☐	Collate relevant correspondence and calls made to stakeholders for briefing	Operations
☐	Organise briefing with field staff, PHEOC Deputy Controller or delegate, PHEOC Logistics, Legal Branch	Operations
Prior to field departure or 1 day before fieldwork		
☐	Prepare the field box to ensure adequate supply of equipment and batteries are working	Logistics
☐	Ensure paperwork is prepared	Operations, supported by Logistics where needed
☐	Supply food and water to field staff if practicable	Logistics
☐	Identify a suitable parking area at the location	Logistics
☐	Inform the fieldwork team about location to pick up fleet car keys	Logistics
Morning of fieldwork		
☐	Brief all stakeholders at the location regarding the role of the field staff (e.g. NSW police, hotel staff, HealthCare Australia medical staff, etc.)	Operations
☐	Identify PHOEC Legal and PHOEC Logistics points of contact	Operations/Logistics
On returning from fieldwork		
☐	Work with Logistics team to ensure field kits are restocked	Field staff/Logistics
☐	Ensure vehicle (if used) is refilled with petrol as per loan/pool car instructions	Field staff
On day after fieldwork		
☐	Complete debrief summary and submit to Operations Team Leader	Field staff
☐	Debrief with the Operations Team Leader and/or PHOEC Deputy Controller or delegate	Field staff/Logistics

develop collaborative relationships that were especially important during prolonged outbreak responses. This was in addition to supporting the investigation of outbreak sources; training, assessment and monitoring of IPC measures; and identification of further cases through collection of SARS-CoV-2 samples and review of clinical records. Onsite deployment of public health fieldwork staff can support residential aged-care facility staff and can expedite outbreak investigation and implementation of effective control measures.

Fieldwork can pose challenges for the safety of public health staff. During the COVID-19 pandemic in NSW, identification of potential exposures to SARS-CoV-2 required fieldwork staff to self-isolate as close contacts, as per national guidelines.[1] A risk assessment determined that the likelihood of exposure was relatively low; however, the potential consequences – specifically, further transmission to colleagues in the PHEOC – were considered severe. This experience catalysed the prioritization of systematic preparation to reduce the risk of such exposures. Anecdotally, a revised protocol that strengthened systematic preparation (e.g. by including checklists of key PPE required) helped to make fieldwork staff feel safer during their deployments.

We recommend the routine inclusion of briefings before and after fieldwork as a way to support fieldwork staff. Our recommended approach is for a senior public health practitioner to be dedicated to supporting the field

Fig. 3. **Post-fieldwork debrief form, NSW Health**

1. Date and location of site visit:

2. Name and role of PHOEC field team member:

3. Purpose of visit:

4. Do you feel you were sufficiently briefed and prepared for the visit?

☐ Yes ☐ No

If no, please specify why:

5. Please identify and describe aspects of the visit that went well:

6. Please identify and describe aspects of the visit that did not go well (if any):

7. Do you have any comments regarding areas of improvement for future site visits?

8. Did any incidents occur that may reflect negatively on field team staff or future operations?

☐ Yes ☐ No

If yes, please summarise:

9. Did any incidents occur that may reflect positively on field team staff or future operations?

☐ Yes ☐ No

If yes, please summarise:

We recognise some staff, being in unfamiliar situations, may sometimes experience unexpected and delayed reactions. Please note that support is available through EAP [Employment Assistance Programme] or your manager.

team and facilitating briefings and debriefs. A briefing is an opportunity to convene the fieldwork and support teams; clarify roles, objectives and responsibilities; and confirm risk assessment and mitigation strategies. Clear lines of communication were established for fieldwork staff to escalate concerns and obtain decision-making support during deployment. In facilitating the debrief, it is important to create space for open disclosures of challenges encountered, so that learnings from each field visit can be incorporated into institutional knowledge. Before the development of the protocol, debrief sessions were (perhaps appropriately) a low priority in the context of an ongoing emergency response. However, after implementing the protocol, debrief sessions became routine and normalized, which facilitated further improvements to staff experience, protocol development, and the reporting of adverse experiences and events.

In our view, maintaining the safety of team members must be the primary priority during fieldwork. IPC, onsite risk assessments and requisite modification of activities should be undertaken immediately before and during the field visit to reduce the risk of exposures. PPE should be considered a last line of defence, as a mental prompt for fieldwork staff to first consider other measures to reduce risk (e.g. videoconferencing, using tools such as maps of facilities or risk management matrices, physical distancing and referring sample collection to experienced clinical staff). Where there is a need for PPE, fieldwork staff require comprehensive training in the use of PPE well in advance of a proposed field visit. This training should incorporate best practice techniques and pragmatic approaches (e.g. recognizing and appropriately managing PPE breaches).

Public health decisions for COVID-19 generated highly emotive community responses and close media interest, particularly where isolation or travel restrictions were required. We therefore recommend deploying fieldwork staff in teams of at least two for safety and security reasons. Pairs of staff can also support identification of PPE breaches and supervise donning and doffing of PPE for each other. We suggest that teams include senior public health practitioners where possible. Senior staff can provide important training and support for junior or surge staff, and their experience can facilitate attainment of fieldwork goals. Although multidisciplinary public health practitioners can effectively undertake fieldwork, we recommend inclusion of at least one clinical team member in case of unexpected requirements for clinical sampling of potential cases or other clinical needs. Factors to consider when composing the team include individual scope of practice of team members, and professional and organizational liability for public health decisions, including implementing public health orders and providing clinical care in the field setting.

In an ideal setting, there would be physical separation of fieldwork staff from other staff in the workplace, to minimize risk of workplace transmission. However, in practice, the scarcity of public health personnel may preclude ongoing separation. Nonetheless, remote work and rostering arrangements could be optimized to reduce the exposure of other public health staff during the incubation period immediately following potential exposure from fieldwork. Where this cannot be achieved, it becomes imperative for fieldwork staff to be supported to immediately openly disclose any potential exposures incurred during fieldwork or the evolution of subsequent symptoms. To ensure there are no incentives to avoid open disclosure, we recommend establishing organizational processes, such as access to appropriate paid leave arrangements and support to manage self-isolation. For example, NSW Health, alongside other Australian jurisdictions, has made alternative accommodation options available to support health-care workers who are required to self-isolate, to reduce the risk of household transmission.[9,10]

DISCUSSION

There are currently no publications exploring the benefits and challenges of public health fieldwork and optimal processes for such fieldwork. The NSW Health experience highlighted that fieldwork is a crucial component of effective public health responses during the COVID-19 pandemic; we are therefore sharing our learnings from fieldwork in pandemic settings. We believe the principles and approach described in the protocol can be readily adapted, implemented and scaled to support fieldwork in response to other outbreaks, including future emerging infectious diseases. These approaches may also be applicable across a wide range of resource and health system contexts.

We recognise that in low-resource contexts, safely conducting fieldwork can be especially challenging but it remains crucial, particularly to prevent transmission among limited staff. An important risk mitigation strategy is implementation of IPC measures, including appropriate use of recommended PPE. The global impacts of the COVID-19 pandemic have caused significant shortages of PPE, requiring rational use and prioritization.[11] However, training in PPE by IPC experts can support judicious and effective use of limited supplies. Where possible, we recommend the deployment of senior public health staff whose experience and authority can contribute to effective fieldwork. However, such experienced staff are themselves limited resources in a pandemic context, and ensuring their safety and capacity to continue contributing to the broader pandemic response is essential. It is imperative that health authorities ensure effective risk management of fieldwork, and that fieldwork is considered a part of workplace obligations. We encourage public health practitioners in low-resource contexts to consider the principles discussed in this paper when developing context-specific fieldwork protocols.

It is also important to acknowledge the potential impact on staff well-being following fieldwork and especially following occupational exposure. In the early period of the pandemic response, the complications and risks of COVID-19 were poorly understood, causing substantial anxiety among health-care workers, particularly regarding the risk of transmission to their families.[12] Fieldwork may itself involve challenging stakeholder management and other stressors, after which staff may experience a delayed psychological response; hence, they should be supported to obtain formal assistance as required. Before fieldwork deployment, managers should consider whether staff have pre-existing medical conditions that may make them more vulnerable to severe illness and, if so, make provisions to mitigate risks.

CONCLUSION

Deploying public health staff to conduct fieldwork in various outbreak settings is an important aspect of the NSW public health response during the COVID-19 pandemic. Our experience and lessons learned in developing a protocol for effectively equipping staff with the skills, knowledge and expertise to perform fieldwork safely may assist other jurisdictions in their public health response and control efforts, both with COVID-19 and other outbreaks. To receive a copy of the protocol, please contact the corresponding author.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Ethics statement

Formal ethical approval was not sought as research was not undertaken. Fieldwork activities undertaken and described in this paper were part of the emergency public health response under the Public Health Act of NSW, under the delegation of the Chief Health Officer. Approval and permission to publish was received through the NSW Ministry of Health before submission for publication.

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Tool for tracking all-cause mortality and estimating excess mortality to support the COVID-19 pandemic response

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Problem: Quantifying mortality from coronavirus disease (COVID-19) is difficult, especially in countries with limited resources. Comparing mortality data between countries is also challenging, owing to differences in methods for reporting mortality.

Context: Tracking all-cause mortality (ACM) and comparing it with expected ACM from pre-pandemic data can provide an estimate of the overall burden of mortality related to the COVID-19 pandemic and support public health decision-making. This study validated an ACM calculator to estimate excess mortality during the COVID-19 pandemic.

Action: The ACM calculator was developed as a tool for computing expected ACM and excess mortality at national and subnational levels. It was developed using R statistical software, was based on a previously described model that used non-parametric negative binomial regression and was piloted in several countries. Goodness-of-fit was validated by forecasting 2019 mortality from 2015–2018 data.

Outcome: Three key lessons were identified from piloting the tool: using the calculator to compare reported provisional ACM with expected ACM can avoid potential false conclusions from comparing with historical averages alone; using disaggregated data at the subnational level can detect excess mortality by avoiding dilution of total numbers at the national level; and interpretation of results should consider system-related performance indicators.

Discussion: Timely tracking of ACM to estimate excess mortality is important for the response to COVID-19. The calculator can provide countries with a way to analyse and visualize ACM and excess mortality at national and subnational levels.

PROBLEM

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was identified in late December 2019 and declared a pandemic by the World Health Organization (WHO) on 11 March 2020.[1] In the WHO Western Pacific Region, by the end of November 2021, there were 10 221 280 confirmed COVID-19 cases and 141 864 deaths.[2] Although the COVID-19 death count is essential to understanding the epidemiology of COVID-19, the attributable mortality due to COVID-19 remains unclear. In any given country, official statistics may not reflect the actual number of lives lost to the disease.[3]

Identifying deaths from COVID-19 is difficult, especially in low-resource settings.[4] Many countries have limited capacity for COVID-19 testing at national and subnational levels, and therefore no capability to track the spread of COVID-19. Even where cases are adequately detected, some deaths may not be reported promptly or even at all.[4] Also, reporting of cause of death may be inaccurate because the quality of death certification depends on the knowledge and skills of physicians, on the characteristics of the deceased person (older people are the most difficult to certify correctly), on errors in coding the death event and on the format of certification.[5] There can also be a long lag between the death occurring and being certified, especially for deaths outside hospitals or other health-care facilities, or those that require an autopsy. Service interruptions due to the pandemic may further delay the death certification process.

According to an internal rapid assessment in the WHO Western Pacific Region, most Member States have two to four death reporting systems. Most systems are

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electronic or partially electronic, and although some are well-integrated within civil registration and vital statistics systems, others are disjointed. The United Nations Statistics Division estimated that death registration coverage is over 80% in 15 of the 27 Western Pacific Regional Member States with data available.[6] Total death counts, reported either weekly or monthly, are publicly available from at least six Member States, and data are available internally from at least four. Thus, it may be feasible for several Member States in the WHO Western Pacific Region to track all-cause mortality (ACM) to provide timely information on COVID-19 deaths. Ideally, deaths would be reported as soon as possible, with more detailed information (e.g. cause of death) reported later when death certificates become available.

CONTEXT

Tracking current ACM and comparing it with expected ACM from pre-pandemic data can provide an estimation of the overall burden of mortality potentially related to the COVID-19 pandemic.[4] This method requires first estimating the number of deaths that would be expected if the COVID-19 pandemic had not occurred (i.e. expected deaths) using historical data and a sophisticated statistical model.[7] Excess mortality is then estimated by comparing the current reported provisional deaths with the expected deaths.[8]

The excess mortality may be directly or indirectly due to COVID-19. Indirect deaths due to COVID-19 include those linked to conditions that were present before the pandemic and have resulted in death because health systems were overwhelmed, those due to patients avoiding health-care facilities and those linked to routine service delivery interruption for non-COVID-19 disease. These indirect deaths due to COVID-19 are not captured in the COVID-19 death numbers reported to WHO.[9] Given that COVID-19 deaths can influence national and subnational response measures, additional effort is required to ensure that this information is readily available and quickly tracked.

A common method to estimate the expected ACM is to use the average death count for each week over a 5-year period. However, this method does not account for the seasonality of mortality, or for the trend and smoothness of expected mortality from week to week or month to month. Additionally, if a trend is present over time, using historical averages will not capture the trend or allow it to be projected into the future. A more sophisticated method by Weinberger et al.[10] fits Poisson regression models that adjust for seasonality, year-to-year baseline variation, influenza epidemics and reporting delays. Our statistical model, the WHO Western Pacific Regional Office ACM calculator (hereafter, the ACM calculator), is based on this method.

ACTION

The WHO Western Pacific Regional Office ACM calculator

The ACM calculator was developed to assist Member States in the WHO Western Pacific Region in tracking and analysing ACM.[11] The user enters the relevant ACM data into the designated template in the calculator, and the expected ACM and excess mortality are calculated.

The calculator can be used online or installed onto a local machine. The input data are never stored offline and are only accessible to the user. Depending on the amount of data entered, the calculator will finish computing within seconds or minutes. Various outputs are available, including disaggregated results; for example, the calculator can provide expected ACM by age group and sex if the data entered are disaggregated by these factors. The results can be displayed in a variety of formats, including tables and graphs.[11]

Statistical methods

The ACM calculator is based on the model of Weinberger et al.,[10] but uses non-parametric negative binomial regression. This approach was preferred to Poisson regression because it allows for overdispersion and can account for instances of low or zero counts.[10] The mean function includes a smooth trend and a smooth non-parametric annual cycle in mortality over time. These terms were specified using cubic smoothing splines, including a cyclical one for the annual cycle. The model allows for arbitrary time-varying covariates, and the parameters were estimated through restricted maximum likelihood estimation. The methodology does not currently adjust for influenza epidemics and reporting delays because this information is not consistently reported.

The expected ACM deaths are forecast stochastically, to represent uncertainty in the estimate of the expected. Thus, statistical significance in observed data can be determined (i.e. a substantial increase or decrease from the baseline). The forecast is an average over the sampling distribution of the parameter estimates, which is a simple way to account for uncertainty in the expected deaths, in addition to the sampling variation of the counts for given model parameters. This approach is preferred to a formal Bayesian model because of its simplicity. The model goodness-of-fit was validated by forecasting 2019 mortality from 2015–2018 data (see **Appendix** for details). The validation indicated that the statistical coverage of the procedure is close to its nominal rate and that the prediction interval lengths are smaller than those based on the historical average model. The intervals based on the historical average are misleading and their actual coverage is far below their nominal coverage.

The calculator was developed using R statistical software (ver. 4.1.2), which includes the estimation of historical patterns and the computation of expected ACM. The software computes the excess mortality from 2020 to the present time; displays different visualizations of expected ACM and excess mortality and allows these visualizations and their raw data to be downloaded for further analysis and inclusion in reports; and includes interactive help and documentation of the methodology. The software is open-source. For reproducibility purposes, the exact code used for the analyses in this paper is in a static archive.[13]

OUTCOME

The ACM calculator has been tested using publicly available data from several Member States. Two examples are provided to highlight key lessons from implementing the calculator.

The first example from one country (January through September 2020) compares ACM plots using the calculator versus ACM plots based on historical averages only. The results from the calculator showed that the recorded counts were well within the 95% prediction interval generated (**Fig. 1A**). Although the reported counts were sometimes above the expected counts (most notably in August), the reported counts were always within the prediction interval. In contrast, the recorded counts based on the historical average only were well above the historical average (**Fig. 1B**) but confidence intervals and statistical increase were not calculated. The calculator values are above the historical average because of the presence of an upward trend in reported counts from 2015 to 2019; the calculator takes this into account whereas the historical average does not. Because historical averages do a poor job of predicting, comparison with the monthly average alone would lead to false conclusions.

The second example illustrates the ability of the calculator to show hidden excess mortality within subregions based on disaggregated data. Using data from another country, the national data indicate no excess mortality over a particular period (**Fig. 2A**), whereas the data for that period from a single local region show excess mortality during July and August that is outside the 95% prediction intervals for these months (**Fig. 2B**). Therefore, the excess mortality for July and August is statistically significantly different from zero (even after adjusting for multiple comparisons).[7] This example highlights the value of being able to analyse subregions, because excess mortality may not be identifiable at the national level in some cases.

Lessons identified

Three key lessons were identified from piloting the tool: using the calculator to compare reported provisional ACM with expected ACM can avoid potential false conclusions from comparing with historical averages alone; using disaggregated data at the subnational level (e.g. by region, sex and age) can detect excess mortality by avoiding dilution of total numbers at the national level; and interpretation of results should consider system-related performance indicators such as system coverage, completeness and reporting delays.

Suggestions for interpreting results

Given that the quality of mortality reporting varies greatly within and between Member States, the results of the ACM calculator should be interpreted with caution. Death coverage may differ if mortality reporting systems do not cover all death counts, with inconsistencies if a country has multiple systems, especially in low-resource settings. Civil registration of deaths is often below 20% in low- and middle-income countries.[4] There are also timeliness issues and reporting delays, so the death count may be

Fig. 1. **A) Monthly reported ACM compared with expected ACM for the first 9 months of 2020 using the calculator. The red zone is the 95% prediction interval. B) Monthly reported ACM compared with the expected ACM and the historical average ACM. The blue lines plot the recorded number of deaths, the orange the expected number of deaths under the model and the green the average number of deaths by month during 2015–2019.**

Fig. 2. **ACM at the national (A) and subregional level (B) within the same member state in the WHO Western Pacific Region. Looking at the aggregate would lead to a conclusion of no excess mortality present; however, by disaggregating the data into subregions we can identify areas where significant excess mortality is present.**

incomplete for certain periods (e.g. the latest week or month). It can take more than 12 months for mortality data to be finalized at the national level owing to deaths not being promptly reported or registered by subnational authorities, a long lag between a death and completion of the death certificate, a backlog at the subnational level that delays reporting to the national level and long processing times for the reporting systems. The use of disaggregated data to improve monitoring sensitivity may be affected by differences in the severity of COVID-19 transmission between subnational regions; also, the impact may vary among different population groups (e.g. by sex, age and occupation).

Proactively tracking ACM at the local level may help to capture more timely information, given that reporting and validation from the local to the national level may take several months to complete. Also, in both the short and long term, careful interpretation of the results is crucial to tailor specific actions based on conditions within each Member State.

For countries with existing systems that cover compulsory and universal mortality reporting, it is important to make use of the existing data to monitor weekly and monthly trends, to drive decision-making. For countries with low levels of mortality reporting coverage, it is still worth monitoring weekly and monthly trends based on available data; however, results should be interpreted with caution, as mentioned above. Additional resources or channels (e.g. burial or cemetery registration) can be employed to track total death counts. Community based mortality reporting should also be considered if necessary.

Limitations

There are two main limitations to the calculator. First, our methodology assumes that reported counts are the actual values and that reports are complete and accurate. However, provisional death counts are normally used for timely monitoring. Results should be compared with in-place systems, as mentioned above. Second, the fundamental assumption is that the statistical variation in ACM during the historical period (2015–2019) is the same as that from 1 January 2020 onward in the counter-factual situation where there was no pandemic. This is not directly testable because of confounding by the pandemic itself. In addition, it is assumed that the negative binomial regression model is adequate to capture this variation, and that counts are independent from period to period (conditional on the annual cycle and covariates). If these assumptions are incorrect, the estimates and prediction intervals will be inaccurate and probably overly optimistic.

DISCUSSION

During an epidemic or other public health emergency where mortality occurs, such as the COVID-19 pandemic, many countries experience disruption to routine health-care services and socio-behavioural changes in the population. For example, 90% of countries have reported disruptions to essential health services since the COVID-19 pandemic began.[12] These changes, together with a lack of reliable data and reporting systems, make the true burden of the pandemic difficult to quantify. ACM, when reported in a timely manner, can be used to estimate excess mortality, providing a rapid snapshot of the situation to support decision-makers to identify the extent and progression of the pandemic. Analysing and interpreting ACM data (including disaggregated data) can also provide important information about who is dying and where, which can then guide decisions on targeted surveillance and efficient use of health resources. The ACM calculator was developed to make it easy for Member States to analyse and visualize their ACM data. Users reported that the tool allowed them to analyse data on their own and easily generate results. Although the underlying statistical model is sophisticated, the use of complex algorithms in the background provides state-of-the-art summaries in the foreground. The model is standardized for a broad user base but could be customized for the needs of specific Member States. However, caution should be exercised when interpreting the results.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethics statement

This work did not require ethics committee review because it did not involve human participants or active intervention. All data are publicly available.

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Culturally and linguistically diverse voices and views in COVID-19 pandemic plans and policies

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Objective: This paper presents a rapid assessment of coronavirus disease 2019 (COVID-19) pandemic plans and explores the representation of culturally and linguistically diverse (CALD) communities in such plans. Four levels of pandemic plans were reviewed: regional, state, national and international.

Methods: Discussions with representatives from four CALD communities informed the development of search and selection criteria for the COVID-19 plans, which were gathered and assessed using a CALD lens. Six COVID-19 pandemic plans that met the inclusion criteria were critically assessed.

Results: The reviewed plans did not report any CALD community voices, views or consultations with community groups in the development phase, nor did they acknowledge the diversity of CALD populations. A few plans noted the vulnerability of CALD communities, but none discussed the challenges CALD communities face in accessing health information or health services during the pandemic, or other structural barriers (social determinants of health).

Discussion: Our analysis revealed major gaps in all pandemic plans in terms of engaging with immigrant or CALD communities. Policies and plans that address and consider the complex needs and challenges of CALD communities are essential. Collaboration between public health services, multicultural services and policy-makers is vital for the inclusion of this higher-risk population.

In Australia, as in other developed nations, the coronavirus disease 2019 (COVID-19) pandemic has disproportionately affected culturally and linguistically diverse (CALD) communities. In many countries, immigrant communities have experienced higher rates of COVID-19 infection, hospitalization, severity of disease and death.[1–3] We know that, in Australia, the risk of transmission and serious illness from COVID-19 is not equal across the population – one vulnerable population disproportionately impacted by COVID-19 is people from CALD backgrounds.[4]

The discrepancies in outcomes between CALD and non-CALD populations evident through the COVID-19 pandemic were also seen during the 2009 H1N1 pandemic.[5,6] It has long been argued that the principles of social justice and corrective justice must be applied in pandemic planning, to enable risk reduction in populations where the need is greatest.[7]

Families and communities are the ultimate recipients of the effects of pandemic plans, and thus need to be involved in their development. Any pandemic health policy or plan must address the public's real concerns and needs, especially among groups who are at higher risk, because this will lead to a reduction in risk for the whole population.[8,9] Not engaging with vulnerable communities when developing health policies or plans is not only unfair but also endangers the health of the broader population.[9]

This article presents a rapid assessment of COVID-19 pandemic plans applicable to the region of the public health unit (PHU) conducting the study. It explores whether the needs, expectations and challenges of CALD communities are represented in these plans. The terms "immigrant" and "CALD communities" are used interchangeably here. The study did not include a review of all relevant literature or research papers;

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rather, the focus was on pandemic plans and policies at multiple settings and levels (from regional to international).

METHODS

Pandemic plans at regional, state, national and international levels were selected, accessed and then critically assessed through a "CALD lens".

The selection criteria included plans that were:

- available online at the time of assessment;
- updated or published within the past 5 years; and
- applicable to the region or state of the PHU undertaking the review, to a neighbouring state or to international plans published by the World Health Organization (WHO).

As part of using a CALD lens, discussions with representatives from four CALD communities informed the development of the search and selection criteria. These key informants were emailed a series of questions. Four consumer representatives of local multicultural health services then discussed the emailed questions with the informants to finalize the assessment questions. The final questions were as follows:

1. Does the plan describe a governance structure that includes CALD community representatives?
2. Does the plan describe any consultation with CALD communities before or during the development of the plan?
3. Does the plan outline how it reflects and embraces the diversity of CALD communities?
4. Does the plan reference the challenges CALD communities encounter in accessing health systems?
5. Does the plan describe how CALD communities would be involved in the oversight, implementation or review of the plan when it is operationalized?

RESULTS

Six plans met the inclusion criteria and were critically reviewed (**Table 1**). All were found to have major gaps in terms of engaging with immigrant or CALD communities and addressing real health needs and challenges. None of the reviewed plans reported any voices, views or consultations with CALD community groups in the development phase. There was some mention of the significance of community engagement in the process of policy-making, but there were no details on which communities or how to engage with them.

The assessed plans included no acknowledgement of the diversity of CALD populations. When immigrant or CALD communities were named, they were presented incorrectly as generalized and homogeneous communities.

The vulnerability of immigrant and refugee or CALD communities was noted in three plans (the two WHO plans and the COVID-19 Pandemic Plan for the Victorian Health Sector). However, none of the documents discussed CALD community challenges in accessing health information or health services during the pandemic or other structural barriers such as social determinants of health. Also, the documents did not mention factors such as unemployment, crowded housing, visa status, low health literacy, racism and cultural beliefs. A few references were made to challenges in communication between health organizations and immigrant communities, but the plans tended to fall short of addressing solutions for overcoming barriers to reduce risk. Only two plans (the NSW Health Influenza Pandemic Plan and the COVID-19 Pandemic Plan for the Victorian Health Sector) talked about the necessity of providing translated information.

DISCUSSION

In general, Australian policies and plans do not engage with CALD communities, and there is little data regarding the needs of these communities and the challenges they face in accessing health-care systems. This may be an indication of structural racism in the system.[10] Policies and plans that address and consider the complex needs of and challenges faced by CALD communities are essential,[8,9] and their development must include the knowledge and expertise of diverse groups from CALD communities and multicultural service providers. We call for health plans and policies to be redeveloped to be inclusive, culturally responsive and based on consultation with CALD communities. There must be a clear process of engagement, respectful and meaningful

Table 1. **Pandemic plans reviewed by setting**

Plan	Setting	Website
Hunter New England Pandemic Plan for Influenza and Other Respiratory Infections	Regional	https://www.hnehealth.nsw.gov.au, accessed 31 August 2020
NSW Health Influenza Pandemic Plan	State	https://www1.health.nsw.gov.au/pds/ActivePDSDocuments/PD2016_016.pdf, accessed 31 August 2020
COVID-19 Pandemic Plan for the Victorian Health Sector	State	Link is no longer active; available from the corresponding author upon request
Australian Health Sector Emergency Response Plan for Novel Coronavirus (COVID-19)	National	https://www.health.gov.au/resources/publications/australian-health-sector-emergency-response-plan-for-novel-coronavirus-covid-19, accessed 31 August 2020
COVID-19 strategy update, World Health Organization	International	https://www.who.int/publications/m/item/covid-19-strategy-update, accessed 31 August 2020
Operational planning guidelines to support country preparedness and response, COVID-19 strategic preparedness and response plan, World Health Organization	International	https://www.who.int/publications/i/item/draft-operational-planning-guidance-for-un-country-teams, accessed 31 August 2020

two-way communication between policy-makers and CALD communities to identify culturally appropriate and effective public health control strategies.

CONCLUSION

Despite the health inequities faced by people from CALD communities, their voices and needs were not reflected in the pandemic plans assessed in this study. The plans failed to address embedded inequities, which are particularly important in health emergencies. It is recommended that CALD communities be included in the development and implementation of pandemic plans. Further research should be undertaken with diverse communities to enable effective public health actions for COVID-19 and future pandemics.

Conflicts of interest

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Strengthening health systems resilience using environmental surveillance for COVID-19 and antimicrobial resistance in the Philippines

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As an early warning strategy for coronavirus disease 2019 (COVID-19), environmental detection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in wastewater was integrated into pandemic responses in Australia, Germany, New Zealand, the United Kingdom of Great Britain and Northern Ireland, and the United States of America.[1–3] Research on methodologies for wastewater surveillance (WWS) for SARS-CoV-2 has been undertaken in Ecuador, France, India, Israel, Italy, Japan, the Netherlands, Spain and Turkey, to name a few.[1] WWS of SARS-CoV-2 has been demonstrated as an early warning system for outbreaks of COVID-19[3] and could be a useful tool for communities across the Philippines.

Antimicrobial resistance (AMR) is a pervasive global health concern, complicating treatment of infectious diseases and routine medical procedures. The Philippines has experienced increasing numbers of infections resistant to specific antibiotic combinations, for example, carbapenem resistance in *A. baumannii* has increased from below 30% in 2009 to 56% in 2017.[4] Globally, reservoirs of antimicrobial-resistant genes (ARGs) have been found in wastewater. This is of interest to health-system managers as ARGs found in wastewater treatment plants have been shown to follow patterns of resistance in clinical isolates.[5]

New molecular diagnostic laboratories established for the detection of SARS-CoV-2 in the Philippines could be utilized for other emerging infectious diseases and, thus, contribute to improved resilience during future epidemics. This article discusses how the strengthened monitoring and surveillance capacity developed for SARS-CoV-2 in the Philippines provides opportunities for environmental surveillance of emerging infectious diseases and AMR.

Environmental surveillance, specifically WWS, could be used as an adjunct to clinical and laboratory diagnosis of individuals for the detection of local outbreaks. Similar to clinical testing, WWS utilizes reverse transcription-quantitative polymerase chain reaction (RT-qPCR).[1,2] Community outbreaks of COVID-19 could, therefore, be detected using WWS regardless of the local government's capacity for clinical testing. As SARS-CoV-2 can be shed through stool, WWS can detect possible outbreaks from symptomatic and asymptomatic members of the population even before community cases or hospital admissions are reported. Targeted testing of communities guided by WWS reduces the need to test larger populations, thus reducing the cost to governments.[2]

It is possible for WWS to detect and analyse chemical or biological compounds to understand the health status of communities.[1,2] Public health and research teams have previously used environmental surveillance for antimicrobial-resistant organisms, ARGs[5] and the Global Polio Eradication Initiative.[6] Detection and quantification

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of SARS-CoV-2 and ARGs in wastewater provides a risk assessment opportunity for the identification of communities at risk of COVID-19 outbreaks and AMR patterns from hotspots such as medical facilities. This practice could provide early warning to health authorities and increase case-finding efforts for COVID-19 in targeted communities. It could also improve infection prevention and control in AMR-affected medical facilities (**Fig. 1**).

The Philippines has recently increased its molecular laboratory testing capacity for SARS-CoV-2. The number of public and private sector laboratories with the ability to detect SARS-CoV-2 using polymerase chain reaction (PCR) increased from one in the first quarter of 2020 to 247 by the end of April 2022.[7] Prior to the pandemic, capacity in molecular diagnosis for infectious disease was tasked to the Research Institute for Tropical Medicine (RITM), which hosts the Antimicrobial Resistance Surveillance Program with 24 sentinel sites. RITM has also been developing capacity in whole-genome sequencing of AMR.[4]

Compared to human clinical surveillance in the Philippines, AMR surveillance for animal and environmental health is still under development. There have been few studies carried out on the detection of AMR residues in agriculture and food animal production settings.[8] RITM has been strengthening its environmental surveillance capacity through its polio WWS, while select academic institutions in the country are focusing on AMR detection in wastewater and agriculture.[4,8,9] Currently there is no national initiative for SARS-CoV-2 WWS; however, there are research initiatives underway on the topic.

Environmental surveillance must involve multisectoral support from biology, chemistry, clinical medicine, chemical engineering, civil engineering, epidemiology, microbiology, public health and waste management. Such a multidisciplinary support team would ensure a thorough understanding of wastewater infrastructure and microbiological detection methods and its integration into pandemic response and health systems. As the Philippine agency assigned to health protection, the Department of Health (DOH), with RITM, can develop, implement and study the cost-effectiveness of multidisciplinary WWS in the response to emerging infectious diseases.

Bringing Filipino institutions and multidisciplinary professionals together with experience in environmental and clinical surveillance could be a starting point for a national One Health integrated surveillance system where clinical and environmental samples from human health systems, animal health systems, food systems and the environment can be analysed and correlated. This system could inform hygiene, sanitation and infection prevention strategies to reduce the risk of spreading AMR and infectious disease outbreaks of pandemic potential. A One Health integrated surveillance system could increase its reach by building on the growing capacity of Filipino medical technologists in the use of RT-qPCR as they handle more samples due to the surge of COVID-19 cases. Capacity building could also be supplemented by online training from experienced global researchers through today's communication technology. The Philippine Interagency Committee on Antimicrobial Resistance (ICAMR), established in 2014 and comprising the DOH, Department of Agriculture, Department of Science and Technology, Department of Interior and Local Government, and Department of Trade and Industry, could oversee the One Health integrated surveillance system, as the committee is already strengthening surveillance and laboratory capacity for AMR.[10]

As epidemics continue to affect the Philippines, improved preparedness, response and resilience to emerging infectious diseases including AMR could be supplemented by a One Health integrated surveillance system. To implement such a system, the country would need to develop capacity in environmental surveillance, including WWS, making use of existing infrastructure and expertise while exploring possibilities for collaboration with global experts and international partners. National agencies and committees, such as the DOH, RITM and ICAMR, would have to take on responsibility for overseeing and leading this initiative. A multidisciplinary approach and the identification of relevant Philippine institutional partners would be needed to sustain this initiative and prepare for emerging infectious diseases and chronic health-system challenges.

Fig. 1. **Implications of environmental surveillance using wastewater for COVID-19 and antimicrobial resistance**

Equipment checklist	
☐	Field kit backpack. Contents should be personalised to individual staff. Standard kit contents can be viewed in the table below
☐	Swabs (number of swabs required will depend on number of patients)
☐	Pathology request forms
☐	NSW Health ID (and Human Biosecurity Officer ID, if required)
☐	Paperwork (e.g. public health orders, revocation letters)
☐	Mobile phone (PHEOC phones are available)
☐	Fleet car satchel & keys and/or cab charges
☐	Laptop and charger (If required. All staff should ensure their laptops are set up to work remotely before being deployed on fieldwork.)
☐	SIM card for laptop if required

Item	Quantity
Swabs	Varies
Sample collection bags	Varies
Pathology request forms	Varies
Thermometer	1
Thermometer covers	200 (1 box)
Spare batteries	4 (AA)
Hand sanitizer 375 ml	1
Hand sanitizer 60 ml	3
Surgical mask	1 box (50 units)
P2 mask	5
Safety spectacles	2
Face shield	3
Gown	5
Gloves (small)	12 (6 pairs)
Gloves (medium)	12 (6 pairs)
Gloves (large)	12 (6 pairs)
Alcohol wipes	1 canister
Clinnell wipes	1 packet
Yellow waste bags	5

ARG: antimicrobial-resistant gene.

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Conflicts of Interest

The authors have no conflicts of interest to declare.

Ethics statement

No ethics permission or approval was required for the writing of this paper, as it contains no confidential information, experimental data, surveys, interviews, or related clinical or patient samples that may require such permission.

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