Evaluation of the Indonesian Early Warning Alert and Response System (EWARS) in West Papua, Indonesia

Mersi K Manurung1,2, Sarce EN Reo1,3, Jerico F Pardosi4, David J Muscatello1
1University of New South Wales, Kensington, New South Wales, Australia, 2Health Department of West Papua Province, Manokwari, Indonesia, 3Health Department of Kupang Regency, East Nusa Tenggara, Indonesia, 4Queensland University of Technology, Brisbane, Queensland, Australia
Correspondence to: Dr David J Muscatello (david.muscatello@unsw.edu.au)

Abstract

Background The Early Warning and Response System (EWARS) is Indonesia’s national syndromic and early warning surveillance system for the rapid detection of infectious diseases and outbreaks. We evaluated EWARS in the remote West Papua province of Indonesia.

Methods Structured telephone interviews were conducted with 11 key informants from West Papuan health services. EWARS data were analysed for usefulness of reporting.

Results Most respondents reported that EWARS is important and useful in improving early detection of outbreaks. The system has led to increased disease control coordination among health jurisdictional levels in the province. However, respondents noted that the limited number of districts involved in the system affected representativeness, and some stated that only about 30–35% of districts in each regency were involved and trained in EWARS reporting, partly owing to lack of a mobile telephone network. Barriers to complete reporting and response to alerts included limited human and funding resources for surveillance, lack of epidemiological training, and technical limitations imposed by limited internet and mobile communication infrastructure in this remote region.

Conclusion Great progress has been made in integrating West Papua into a nationally consistent disease and outbreak detection system. Strategies for addressing barriers resulting from remoteness, constrained human, funding and laboratory resources, lack of training, and limited internet and communications infrastructure are needed if EWARS in West Papua is to advance.

Keywords: emerging diseases, Indonesia, outbreaks, remote settings, surveillance, West Papua

Background

Disease surveillance is a core capacity under the International Health Regulations, 2005 (IHR), and for strategies to improve early detection of outbreaks that have been developed in various countries.1 Increasing automation of disease reports in low-resource settings can reduce the workload of health workers and increase surveillance sensitivity.2,3 However, implementation of automated surveillance must be accompanied by an evaluation to assess whether or not the system achieves its objectives.4

In 2009, to improve infectious disease control and to comply with the IHR, Indonesia developed a national Early Warning Alert and Response System (EWARS).5 In 2015, the EWARS website, an automated data capture system, was developed in the capital, Jakarta, to provide the infrastructure for more rapid detection of outbreaks.5 The system uses short messaging service (SMS) text messaging for source data transmission by surveillance officers in district public health centres (puskesmas, short for Pusat Kesehatan Masyarakat in Indonesian). An internet-based wide area network is used to distribute the processed surveillance statistics and resulting reports to regional health jurisdictions for review and possible action. The aim is to detect cases of certain serious infectious diseases or unusual disease patterns signalling possible outbreaks of common or rare infectious diseases.7,8

West Papua (Papua Barat in Indonesian) is one of the least developed provinces of Indonesia. It includes 13 administrative subregions (12 regencies and one city). The total area of West Papua is approximately 100 000 km², and in 2017 it had a total population of 915 361; its Human Development Index score is the second lowest among those of the 34 Indonesian provinces.9 With regard to health, the number of infectious diseases, such as malaria and diarrhoeal diseases, has decreased over time but is still higher than those of other provinces. For instance, in 2015 West Papua’s number of positive malaria cases per 1000 population was 31.3, the second highest rate in Indonesia after that of Papua province.10
It is essential to evaluate the implementation of EWARS in low-resource settings with high rates of infectious diseases. This study used well-established guidelines to evaluate the operation of EWARS in Indonesia’s West Papua province.

Methods

Study design
The Updated guidelines for evaluating public health surveillance systems published by the Centers for Disease Control and Prevention (CDC) were applied.11 Qualitative data on the operation of the system were collected during September 2018 using semi-structured interviews with key informants involved in the operation of EWARS at various levels of the provincial health governance structure. The questionnaire, developed using the CDC guidelines in English and Bahasa Indonesia, is available from the corresponding author. The questionnaire was piloted in another province and revised as a result.

Count data relating to the diseases and syndromes monitored by EWARS from week 42 (week commencing 12 October) 2015 to week 52 of 2017 were extracted from the EWARS database. The EWARS database includes only aggregated weekly counts of diseases reported by health centres, which can be retrieved using the EWARS website provided by the Indonesian Ministry of Health.

In 2018, there were 159 puskesmas in West Papua province, and most were registered in EWARS. Participants were identified based on the human resource database for EWARS. There are no guidelines on the number of surveillance officers per puskesmas. Since infectious disease surveillance is a health programme operating through puskesmas and the District Health Office, there should be at least one person dedicated to running the programme at each site.

Purposive sampling was used to select participants in the interview. We chose sites to give a selection of urban, rural and remote settings. Prior to the interview, the respondents were asked how long they had been working as a person with EWARS responsibility. If the duration was more than 1 year, they were included in the study. Fourteen key informants and stakeholders responsible for the EWARS programme in West Papua were selected for interview, consisting of eight managers and EWARS officers in health departments at provincial and regency government levels and six EWARS data providers in puskesmas at local government level.

Interviews lasted between 30 and 60 minutes and were carried out in Bahasa Indonesia by telephone from Sydney, Australia. Verbal consent for participation and audio recording was obtained from each informant before the interview.

Following the CDC guidelines, interview recordings and written notes were thematically analysed and the themes were reviewed by the research team. Aggregate surveillance count data from EWARS for West Papua from 2015 to 2017 were used to assess the usefulness of reporting.

Ethics
The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000. The study was approved by the University of New South Wales Human Research Ethics Committee (HC180628). Permission to conduct the research was obtained from the Health Department of West Papua Province, and Indonesian ethical exemption was granted by the Indonesian Ministry of Health (LB.02.01/2/KE.297/2018).

Results

System objective and description
The aims and operation of EWARS in West Papua are the same as in all the Indonesian provinces; the objective is to reduce the size and impact of outbreaks through earlier detection.

The reporting structure is outlined in Fig. 1. Surveillance data collection begins in subdistrict health centres (pustu). Aggregate counts of diseases and disease syndromes are collected by health workers (nurses, midwives, etc.) and forwarded to the surveillance officer at the puskesmas by SMS, phone or hand delivery. These data from the pustu are then aggregated by the puskesmas surveillance officer with data from the district puskesmas and sent as one SMS to the national Ministry of Health’s application programming interface (API) in the central EWARS computer system. The API transfers the data to the central EWARS database, where they are automatically aggregated, analysed and reported on the central EWARS website.

The SMS message constructed by the surveillance officer is assembled as follows: epidemiological week, disease code 1 and number of cases, disease code 2 and number of cases, and so on, plus the total number of patients visiting the site in 1 week along with the code for the site. The disease codes are single alphabetical characters unique to the system.7

Each week, surveillance officers at the regency/city and provincial levels review the data reported on the national EWARS website for their jurisdiction. They verify alerts and coordinate with surveillance officers at the puskesmas level. If necessary, they initiate a response, including outbreak investigation and control measures. This may include collecting specimens from cases. The specimens are sent to the national diagnostic laboratory. Based on the results, regency/city and provincial officials determine whether or not an outbreak or other response is required. Laboratory confirmation for some diseases, such as malaria, can be carried out by a local laboratory at the puskesmas level.

Each disease under surveillance has an alert threshold, with criteria varying by disease or syndrome category. The threshold values consist of criteria such as “increase in cases” (meaning the number of cases has doubled or more than doubled compared with the previous period); that particular criterion is used for categories including diarrhoea, malaria, suspected cases of dengue fever, bloody diarrhoea, influenza-like illness and pneumonia. For categories with very low probability per unit of time, such as suspected typhoid or chikungunya, a Poisson distribution-based threshold is applied. The category “cluster of unknown disease” uses a “three cases” threshold criterion. Suspected cases of measles, diphtheria or pertussis have a “one case” criterion for reaching the alert threshold.7

Interview results
Six of the eight selected provincial and regency key informants and five of the six in puskesmas were interviewed; there were 11 respondents in total from the 14 invited to participate. The
remaining selected informants were unable to be contacted for interview. City-level informants could not be contacted. Five respondents had a bachelor’s degree in health and six had health diploma qualifications. Respondents included managers of the surveillance programmes and EWARS officers at provincial and regency health offices, and designated EWARS surveillance officers in puskesmas.

**Personnel and infrastructure to operate EWARS**

At the puskesmas level, two of five respondents reported that there were two surveillance officers in their workplace, while the rest reported one surveillance officer. Four had attended EWARS training. At the regency and provincial levels, all respondents reported being the only surveillance officer in their workplace and all had attended EWARS training. All respondents had multiple work roles, including their EWARS responsibilities, and four of 11 noted difficulties in managing competing priorities.

Nine of 11 respondents were aware of, and had a copy of, the EWARS guidebook. Seven had access to the forms needed to conduct an outbreak investigation. At the regency and provincial levels, two of six stated that they did not have access to Wi-Fi or internet services, while the remaining four reported that, although they did have Wi-Fi in their workplace, it was not always reliable. They considered this and limited mobile network connectivity to be the biggest challenges they faced. Two respondents mentioned having a workplace computer for EWARS, while the remaining four used their own private laptop computers.

**Funding resources**

At the puskesmas level, the majority of respondents reported that, apart from their salary, funding for EWARS operations was limited. One respondent mentioned having funds for increasing community knowledge about diseases such as diarrhoea and one reported having a budget for outbreak investigations, while the rest of the participants mentioned not having funds to support the EWARS programme. In the cases of puskesmas officers who had access to EWARS funds, those funds were provided by a national government funding programme. At the

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**Fig. 1. Early Warning and Response System (EWARS) data flow, West Papua, Indonesia**

Note: There are several pustu reporting to each puskesmas, there are several puskesmas in each regency or city, and there may be several regencies and cities reporting to each province.
regency and provincial levels, only two respondents reported the availability of funding for EWARS and surveillance activities, and they stated that those funds were insufficient for capacity-building and outbreak investigations. At the regency level, the source of funds is the regional government funding programme, and at the provincial level funding comes from both national and regional programmes.

Most respondents at all levels reported that funding was essential for implementing the system. Limited funds for investigating outbreaks, examining specimens and travelling to remote areas cause difficulties in verifying all alerts produced by the system.

System attributes
Simplicity
All puskesmas respondents considered the system easy to use because reports were sent using SMS. They also thought that the EWARS SMS reporting format was easy to understand, especially after attending EWARS training. Automatic feedback from the central server when the data report was successfully sent was an advantage of the system. All regency and provincial respondents reported that the system was simple to implement. They considered it an advantage that analysis and monitoring of EWARS reports could be done through the EWARS website.

Acceptability
All respondents considered that the system was important for early detection of infectious disease outbreaks. One puskesmas officer stated, “I think this system is important and very good because if there is a dangerous disease in the village, by sending an SMS, the government will immediately know [translated from Indonesian].” The respondents believed that the system was suitable for areas with a functioning mobile telephone network, because of its ease of use and simplicity.

Stability
The majority of respondents reported never having experienced an EWARS outage lasting more than 1 day or 1 week. Some puskesmas respondents had experienced limited availability of mobile telephone networks for sending SMS messages, especially in rural areas. There were delays in weekly reporting from some pustu to puskesmas. EWARS officers who change their cell phone number must re-register it in EWARS and this does not always occur, leading to delays in SMS data reports. Regency and provincial respondents reported that the central EWARS system was quite stable in providing surveillance information. However, unstable internet and Wi-Fi services affected their ability to review surveillance information.

Representativeness
Regency and provincial respondents reported that the limited number of puskesmas involved in the system affected representativeness, and some stated that only about 30–35% of puskesmas in each regency were involved and trained in EWARS reporting, partly owing to lack of a mobile telephone network. At the puskesmas level, the proportion of participating pustu varied. Some reported that it was difficult to obtain data from pustu in remote villages. The solution adopted by puskesmas officers was to empower community members informally trained by health workers (kader) to support community health programmes in distant villages to send surveillance reports or text messages to the puskesmas. Alternatively, puskesmas officers collect data directly during field visits, when operating mobile health centres (pusling) and when implementing other programme activities such as malaria control programmes and immunization programmes.

Timeliness
All puskesmas respondents noted that the delivery of each report usually occurs every Monday or Tuesday for the previous week’s reporting period but that some delays occur owing to competing work priorities, mobile network instability and changes to EWARS officers’ mobile phone numbers. Around half of all respondents reported that EWARS, and not rumour, often provided the first indication of an outbreak. Outbreaks not detected by EWARS occurred in areas not participating in EWARS or were reported by hospitals or private doctors.

Data quality
All puskesmas respondents reported that they understood the EWARS case definitions and all were able to give correct examples of cases meeting the definitions. Some case definitions caused confusion, such as influenza-like illness, suspected human avian influenza, cluster of unknown disease and suspected chikungunya. This was partly as a result of limited knowledge of these diseases and situations. Moreover, not all diagnoses are made by doctors at the puskesmas. In at least one puskesmas, diagnoses are made by nurses, and there are concerns about accuracy. Errors in SMS reports can cause false alerts. A solution implemented by puskesmas officers was, during field visits, to promote to pustu officers the importance of sending accurate data and reports.

At the regency level, efforts to improve data quality included providing regular feedback to puskesmas and providing monthly reports back to puskesmas and pustu. Provincial officers provide capacity-building training to district officials and technical guidance to puskesmas officers, if funds for these activities are available from annual national or regional programmes. In addition, reviews of and feedback on the quality of EWARS data are also carried out regularly.

Usefulness
Based on aggregate data obtained from the EWARS website, there was an increase in alert responses during 2015–2017 (see Fig. 2). Respondents perceived that the system’s usefulness reflected the EWARS objectives, namely early detection of outbreaks of infectious diseases, minimizing mortality and health risks due to outbreaks, monitoring infectious disease trends and assessing the impact of disease control programmes. One puskesmas official stated, “With the reporting of this system, we can know the increasing or decreasing trend of certain diseases in our region so that we can detect outbreaks quickly [translated from Indonesian].” Some puskesmas officers reported that not all objectives were being met.

Most regency and provincial officers stated that EWARS was very useful because of its ability to produce alerts and stimulate prevention and control measures. Some respondents at all levels reported that usefulness was hampered by operational difficulties such as poor mobile networks and inability to include all pustu because of remoteness.
Respondents thought usefulness could be enhanced through advocacy for improving mobile network infrastructure in remote areas, increased stewardship from all administrative levels, and increased funding support for capacity-building, laboratory diagnostics and outbreak investigations. They also suggested that there was a need for improved integration with other surveillance and disease control programmes. Single-sideband modulation radio for data communication from remote pustu was also proposed. Two regencies had established a rapid response team (Tim Gerak Cepat in Indonesian) for early response to outbreaks.

Respondents reported difficulty in confirming infections or outbreaks because local laboratories are only able to carry out limited diagnostics. While there is an absolute threshold ("one case") set for conditions such as measles, diphtheria and acute flaccid paralysis (for poliomyelitis), an inability to diagnose these conditions locally prevents confirmation of infections or outbreaks. Confirmatory diagnostics for many conditions can be provided only by the national reference laboratory.

**Sensitivity**

Sensitivity was hampered by incomplete population coverage because of a lack of mobile network infrastructure in some areas. For example, regency and provincial officers found two outbreaks of dengue fever during 2017–2018 not detected by EWARS. These were detected in puskesmas with mobile network difficulties and from hospital reports. Sensitivity is also influenced by the threshold level used nationally for some diseases, which may not be appropriate in some locations. For instance, as malaria is a frequently reported endemic disease, EWARS officers reported difficulty in determining the number of malaria cases that would indicate an outbreak. As a result, the proportion of malaria alerts that indicate actual outbreaks is difficult to determine.

**Positive predictive value**

Although we do not have data regarding this attribute, respondents estimated that less than 50–70% of alerts signalled actual outbreaks. Regency and provincial respondents stated that there was difficulty in determining positive predictive value because some disease cases or outbreaks are not confirmed or laboratory diagnostic results are sometimes delayed.

**Discussion**

The results of this evaluation indicate that, compared with previous paper-based approaches used in West Papua, EWARS is simple to implement and operate at the provincial level. The method for weekly reporting of disease data via SMS by health workers at puskesmas is a practical and rapid means of reporting diseases based on EWARS case definitions. The majority of respondents reported that this system was important and useful in improving early detection of outbreaks. The system has led to increased disease control coordination among health jurisdictional levels in the province.

Factors such as limited human and funding resources for surveillance, lack of epidemiological training, and technical limitations imposed by limited internet and mobile communication infrastructure in this remote region present barriers to complete reporting and responding to alerts. These obstacles illustrate the difficulty of detecting outbreaks in areas with the greatest need for syndromic surveillance. A possible solution is very low-frequency radio or single-sideband modulation radio.
Integration of reporting into active hospital surveillance and the development of hospital-based EWARS data will be crucial to increasing the usefulness of EWARS. EWARS could be supplemented with systematic event-based surveillance and community-based surveillance to improve its usefulness.16,17

We identified the need, as in other settings,18,19 for laboratory capacity-strengthening to support confirmation of infectious disease outbreaks. Epidemiological training of surveillance officers is also needed. A provincial laboratory supported by trained laboratory personnel, with adequate facilities, tools and materials, could improve the overall performance and the speed of diagnosis.20

A limitation of this study was that respondents from the only city jurisdiction in West Papua were unable to be contacted for interview, thus limiting our findings to the more rural settings in the province. In addition, given the restrictions of limited numbers of key informants and interviews done by telephone from Australia, other aspects of EWARS – such as policy and governance matters, infrastructural issues, the roles and responsibilities of each administrative level of the surveillance system, and monitoring and supervisory functions of EWARS – could not be systematically assessed by this study.

Conclusion
Great progress has been made in integrating West Papua into a nationally consistent disease and outbreak detection system. Strategies for addressing barriers of remoteness, constrained human, funding and laboratory resources, lack of training, and limited internet and communications infrastructure are needed to further strengthen West Papua’s capacity to rapidly respond to and control infectious disease outbreaks as part of Indonesia’s IHR commitments.

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Conflict of interest: Mersi K Manurung is employed by the Health Department of West Papua Province, where the study was conducted. To limit conflict of interest, interviews were conducted by an Indonesian-speaking coauthor, Sarce EN Reo, who is not employed by the Health Department of West Papua Province. All authors declare no other conflict of interest.


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