Evaluation of the influenza sentinel surveillance system in Madagascar, 2009–2014
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Abstract: Evaluation of influenza surveillance systems is poor, especially in Africa. Data on the performance of influenza surveillance systems in other low-resource settings are scarce. The pre-2007 system could monitor influenza activity only in the capital city. Thus, for influenza pandemic preparedness and to satisfy the 2005 International Health Regulations, it became important to implement influenza surveillance throughout Madagascar.

Introduction
The World Health Organization (WHO) recommends that, from no more than two years after implementation, influenza surveillance systems should be periodically and comprehensively evaluated. Such evaluations may enable shortfalls to be identified, performance to be improved and data reliability to be assessed. Although several influenza surveillance systems have been established in Africa, data on the performance of influenza surveillance in Africa are scarce.

Local setting
Madagascar is a low-income country with a health system that faces numerous challenges – including problems in the timely detection of disease outbreaks and the mounting of effective responses to such outbreaks. Although there has been an influenza surveillance system in Madagascar since 1972, in 2007 this system covered only six primary health centres – all located in the capital city of Antananarivo. Between 2002 and 2006, each of the six health centres collected up to five specimens weekly from patients presenting with influenza-like illness (ILI). Staff from the national influenza centre in Antananarivo collected these specimens twice a week. Only one centre reported weekly aggregated data on the numbers of ILI cases recorded among all consultations. Thus, for influenza pandemic preparedness and to satisfy the 2005 International Health Regulations, it became important to implement influenza surveillance throughout Madagascar.

Approach
In 2007, in collaboration with the Malagasy Ministry of Public Health, the Institut Pasteur de Madagascar initiated a countrywide system for the prospective syndromic and virological surveillance of fever. The system was designed to enable the daily collection of data on ILI, the daily reporting of the data to staff at the Institut Pasteur de Madagascar – via a short message service–based system – and the collection of samples to be tested for influenza virus. The main aim of the syndromic surveillance, which was integrated in the general practice of the clinicians at the sentinel sites, was the prompt detection of any influenza-related unusual event, outbreak or seasonal epidemic, especially in areas where laboratory-confirmed diagnoses were difficult to obtain.

To check that the reliable data needed for effective public health interventions were being generated, we evaluated the influenza surveillance component of the fever surveillance system between January 2009 and December 2014. During the study period, influenza surveillance – nested within the fever surveillance – was implemented in 34 public or private health-care facilities spread across Madagascar (available from the capital city).

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influenza-like and other febrile illnesses, Madagascar, 2009–2014

Weekly, at 12 of the sentinel sites, nasopharyngeal and/or oropharyngeal samples were collected from up to five patients with ILI and shipped to the national influenza centre for influenza testing, as previously described.8,9

No financial incentives were provided to the health centre staff for their surveillance-related activities but medical equipment, stationery and training were provided to support such activities.

To evaluate the influenza surveillance system, we followed the relevant guidelines of the United States Centers for Disease Control and Prevention10,11 and considered eight key attributes. For each attribute, specific quantitative and/or qualitative indicators were developed and scored (Table 1).

Data quality, stability and timeliness were evaluated using the central database at the Institut Pasteur de Madagascar. To evaluate the other five attributes, semi-structured interviews and standardized self-administered questionnaires were used to collect relevant data from 85 individuals involved in the surveillance system from the sentinel sites (68 individuals) and from the Institut Pasteur de Madagascar or the Malagasy Ministry of Public Health (17 individuals). However, 18 staff members from sentinel sites failed to respond.

Fig. 1. Flowchart showing the implementation of the national system for the surveillance of influenza-like and other febrile illnesses, Madagascar, 2009–2014

SMS: short message service.

Relevant changes

Between January 2009 and December 2014, 177 718 fever cases were reported from the 34 sentinel sites. Overall, 25 809 (14.5%) of these fever cases were considered to have ILI. Samples were collected from 35.6% (9192) of the ILI cases and tested for influenza; 3573 (38.9%) of those tested were found positive. Table 1 summarizes the results of our evaluation of the influenza surveillance component of the fever surveillance system. The data collected on ILI appeared to be of good quality. Full data on most of the cases observed at the sentinel sites were sent in a timely manner. The case definition of ILI and the sampling criteria also appeared to be respected. However, less than 50% (4265/9293) of the samples collected reached the laboratory within 48 hours of their collection. In terms of representativeness, it seems likely that the low median age of the ILI cases observed at the sentinel sites – i.e. four years – reflects a reluctance of adolescents and adults with fever to seek care. More than 80% (47/50) of the staff interviewed stated that the implementation of their surveillance activities was easy and that the time they devoted to such activities was acceptable. Although none of the interviewees reported delays in the collection of samples from patients, 36 (34%) reported regular delays.
### Table 1. Key findings from the evaluation of the influenza surveillance system in Madagascar, 2009–2014

| Attribute, issue | Indicator | Key findings | Score* |
|------------------|-----------|--------------|--------|
| **Data quality** | Does the information submitted contain all mandatory and/or requested data items and are the data recorded valid? | Proportion of expected SMS messages and CRF that were received | 93.0% (IQR: 70.2–98.1) of expected SMS and 89.5% (IQR: 40.9–95.3) of expected CRF | 3 |
| | Proportion of SMS and CRF without missing or inconsistent value for selected key variables | 99.9% (44 203/44 252) of SMS and 96.6% (117 397/121 543) of CRF | 3 |
| | Proportion of ILI cases that met the case definition | 94.9% (24 490/25 809) | 3 |
| | Proportion of sampled ILI cases that met the sampling criteria | 99.5% (9251/9293) | 3 |
| | Proportion of sampled ILI cases with available laboratory results | 98.9% (9192/9293) | 3 |
| | Proportion of collected variables included in the WHO recommended minimum data collection for influenza sentinel surveillance | Data on antiviral treatment and underlying medical conditions were not collected | 2 |
| **Timeliness** | Are the data and samples from the surveillance system collected and dispatched without delay? | Proportion of SMS texts sent within 48 hours of reference day | 69.8% (IQR: 59.8–77.1) | 2 |
| | Proportion of data collection forms received by IPM within 7 days of data collection | 90.3% (IQR: 81.2–98.1) | 3 |
| | Proportion of samples received by IPM within 48 hours of collection | 45.9% (IQR: 29.9–72.7) | 1 |
| | Proportion of weekly reports issued within the target date | 90.1% (281/312) | 3 |
| **Representativeness** | Are the data collected on influenza by the surveillance system representative of the general population in Madagascar? | Geographical coverage | Surveillance sites located in all provinces | 3 |
| | Inclusion of all age groups | Although all age groups were eligible, median age was only 4 years (range: 1 day–91 years) | 2 |
| **Simplicity** | Do the surveillance staff find the system easy to implement? | Surveillance staff's perceptions of how easy certain surveillance activities are to use – categorized as very difficult, difficult or easy | Of 50 respondents, the collection of aggregated data, the completion of CRF and SMS-based data transfer were reported to be easy by 47, 50 and 50, respectively | 3 |
| | Performance of the courier in collecting CRF from sentinel sites | Of 50 respondents, 27 reported that they had rarely or never experienced delays in the collection of CRF | 1 |
| | Performance of the courier in collecting samples from sentinel sites | All the 18 respondents from sites where samples were collected reported that they had rarely or never experienced delays in the collection of samples | 3 |
| **Acceptability** | Do the surveillance staff and key stakeholders find the system acceptable? | Proportion of surveillance staff that were satisfied with reports and follow-ups | Of the relevant staff interviewed, 17/18, 42/50 and 49/50 reported being satisfied with the virological reports, quarterly bulletins and telephone follow-ups, respectively | 3 |
| | Proportion of work time devoted to surveillance activities | 37% and 25% for the 50 respondents from the sentinel sites and 17 respondents from the IPM, respectively | 2 |
| | Mean annual cost of the surveillance system, for ILI surveillance | US$ 94 364 | 2 |
| **Flexibility** | Could the system be easily adapted to cover illnesses other than influenza? | Number of syndromes surveyed under the fever surveillance system | Four: arboviruses, diarrhoea, influenza and malaria | 3 |
| | Number of pathogens surveyed under the ILI component of the fever surveillance system | The system can detect up to 14 respiratory viruses | 3 |

(continues. . .)
delays in the collection of case report forms by the express couriers. Over our study period, the mean annual costs of the entire fever surveillance system and the laboratory testing of samples were estimated to be 94 364 and 44 588 United States dollars, respectively.

The fever surveillance system appeared capable of monitoring trends in several fever-associated illnesses under a unified platform and appeared to be quite stable, at least in terms of reporting frequency. Each year the national influenza centre shared the isolates of influenza virus that it had recovered with the WHO Collaborating Centre for Reference and Research on Influenza, London, United Kingdom of Great Britain and Northern Ireland.

Lessons learnt
The influenza surveillance system showed good performance in terms of most of the indicators and attributes that we evaluated. One of the system’s main strengths was its data quality – including the respect shown to case definition and sampling criteria. The use of mobile phones and texting for the transmission of daily aggregated data, the follow-up and the relative simplicity of the system contributed to improving the completeness, quality and timeliness of the data and the acceptability of the system to sentinel site staff. The main weaknesses that we observed were the frequent shortages of blank case report forms and inadequacies in the number of staff trained. Although half of the

| Attribute, issue | Indicator | Key findings | Score |
|------------------|-----------|--------------|-------|
| Stability        | Proportion of evaluated weeks during which all sentinel sites were functional | 93.3% (291/312) | 3 |
|                   | Proportion of data queries successfully resolved | 93.2% (137/147) | 3 |
|                   | Availability and use of SOP for surveillance | Of 50 respondents, 29, 46 and 44 reported making regular use of sample collection, decision tree and surveillance procedures, respectively | 3 |
|                   | Frequency of interruptions in supplies | Of 50 respondents, 28, 9 and 36 reported no interruptions in the supplies of CRF, sampling materials and telephone credit for SMS, respectively | 2 |
|                   | Proportion of sentinel sites with at least one member of staff trained in sentinel surveillance procedures | 71.9% (23/32) | 2 |
|                   | Proportion of surveillance staff trained in sentinel surveillance procedures | Training had been received by 66.7% (18/27) of respondents with primary responsibility for surveillance activities and 34.8% (8/23) of respondents who were supporting staff | 1 |
| Utility           | Number of ILI alerts detected | In 2014, 38 alerts were detected in 16 sentinel sites | 3 |
|                   | Proportion of sentinel sites — other than those that collected samples routinely — that initiated collection of samples after local ILI alert | 72.7% (8/11) | 2 |
|                   | Isolation and sharing of circulating seasonal influenza strains | NIC shared circulating isolates with WHO Collaborating Centres 11 times — out of the 12 requested by WHO | 3 |
|                   | Identification capacity for emerging influenza strains with pandemic potential | NIC successfully passed nine external quality assessments, with an overall score of 98.9% | 3 |
|                   | Proportions of surveillance staff that receive the virological reports, the influenza surveillance reports and influenza bulletins | 12 (66.7%) of 18 respondents working at biological sites, 35 (70.0%) of all 50 respondents and 27 (54.0%) of all 50 respondents had reportedly received the virological reports, influenza surveillance reports and the influenza bulletins, respectively | 2 |

CRF: case report forms; ILI: influenza-like illness; IPM: Institut Pasteur de Madagascar; IQR: interquartile range; NIC: national influenza centre; SMS: short message service; SOP: standard operating procedures; US$: United States dollars; WHO: World Health Organization.

The key variables evaluated for SMS data were code of sentinel site, date of patient visit and numbers of fever cases, ILI cases and patients. Those evaluated for CRF were absence/presence of fever with cough and/or sore throat, code of sentinel site and dates of patient visit and symptom onset.

Any of the following were considered to be failures in meeting the sampling criteria: specimen collection tube vial left open; sample without patient identification; absence/presence of fever with cough and/or sore throat, code of sentinel site and dates of patient visit and symptom onset; no corresponding CRF; no identification of the patient; time between date of onset and date of sampling either ≥ 7 days or not available; time between date of sampling and sample receipt at IPM either ≥ 7 days or not available; sampling kit used after its stated expiry date; no diagnosis of influenza.
surveillance staff interviewed reported that the associated workload was the main challenge in the implementation of surveillance activities, all of them reportedly felt that – given the probable benefits to public health – the time they spent on such activities remained reasonable. The delays between the collection of samples and their receipt in the virological laboratory were another issue.

During our evaluation, we used scores based on an arbitrary scale to estimate the quality of the surveillance system in terms of each of the indicators we evaluated. We decided not to give an overall score for each of the attributes we evaluated because the indicators for each attribute are unlikely to have equal importance.

Although the annual costs of the system appeared moderate, the system, at the time of writing, remains entirely supported by external funding. To improve the system’s sustainability, advocacy is needed to promote financial support from the Malagasy Ministry of Health and other national stakeholders.

Ideally, the influenza surveillance system should be nested within an integrated system of disease surveillance based on a syndromic approach. If such a system can be kept simple, its acceptability to surveillance staff and its data quality and timeliness are more likely to be good (Box 1). If such a system is going to be sustainable in the long term, the number of sentinel sites and the tests used need to be tailored to the funds available.

Given its flexibility and moderate costs, Madagascar’s influenza surveillance system may be a useful model for syndromic and laboratory-based surveillance in other resource-constrained settings.

| Box 1. Summary of main lessons learnt |
|---------------------------------------|
| • During 2009–2014, the influenza surveillance system in Madagascar appears to have performed well. |
| • The system apparently provided reliable and timely data. |
| • Given its flexibility and overall moderate cost, the system may become a useful model for syndromic and laboratory-based surveillance in other low-resource settings. |

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**Competing interests:** None declared.

**Lessons from the field**

In 2009 to 2014, we evaluated the data quality and performance of the influenza surveillance system in Madagascar.

The system was implemented by the Malagasy Ministry of Public Health, with support from external partners.

**Key findings**

- The system was simple and cost-effective.
- It provided reliable and timely data.
- The system could be improved by addressing some logistical challenges.

**Implications**

- The system can be a useful model for other low-resource settings.
- Improved data quality is necessary to support decision-making.

**Future directions**

- Continuous improvement of the system and its integration with other surveillance systems.

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**Abbreviations**

- AR: Alain Rakotoarisoa
- IDESP: Integrated Disease Surveillance and Early Warning System
Évaluation du système de surveillance sentinelle de la grippe à Madagascar, 2009–2014

Problème L’évaluation des systèmes de surveillance de la grippe est médiocre, en particulier en Afrique.

Approche En 2007, l’Institut Pasteur de Madagascar et le ministère malgache de la Santé publique ont mis en œuvre un système national de surveillance prospective, syndromique et virologique, des syndromes grippaux. En évaluant les performances de ce système, nous avons repéré certaines lacunes ainsi que des moyens d’améliorer l’utilisation des ressources. Nous avons examiné l’acceptabilité, la qualité des données, la flexibilité, la représentativité, la simplicité, la stabilité, l’actualisation et l’utilité de ce système, et avons développé des indicateurs qualitatifs et/ou quantitatifs pour chacun de ces aspects.

Environnement local Jusqu’en 2007, le système de surveillance de la grippe à Madagascar n’était opérationnel qu’à Antananarivo et les observations qui étaient faites ne pouvaient pas être extrapolées au pays entier.

Changements significatifs En 2014, le système était utilisé sur 34 sites sentinelles, sur l’ensemble du pays. Des prélèvements nasopharyngés et/ou oropharyngés ont été effectués sur 12 sites, avant d’être soumis à un test pour rechercher le virus de la grippe. Entre 2009 et 2014, 177 718 cas de fièvre ont été détectés, sur lesquels 25 809 (14,5%) ont été classés comme syndromes grippaux. Sur les 9192 prélèvements effectués sur des patients qui présentaient des syndromes grippaux, sur lesquels on a recherché des virus de la grippe, 3573 (38,9%) se sont révélés positifs. La qualité des données, pour tous les indicateurs analysés, a été classée au-dessus de 90% et le système présentait également de bons résultats au niveau de son acceptabilité, de sa simplicité et de sa stabilité. Cependant, la réalisation de prélèvements devait être améliorée.

Leçons tirées Le système de surveillance de la grippe à Madagascar présentait de bons résultats et fournissait des données fiables et actualisées pour les interventions de santé publique. Compte tenu de sa flexibilité et de son coût relativement modéré, ce système pourrait devenir une plate-forme utile pour la surveillance syndromique et en laboratoire dans d’autres pays à faibles ressources.
Marco regional Hasta 2007, el sistema de vigilancia de la gripe en Madagascar operaba únicamente en Antananarivo, y las observaciones realizadas no podían extrapolarse al resto del país.

Cambios importantes En 2014, el sistema abarcaba 34 sitios centinela en todo el país. En 12 sitios, se recogieron muestras nasofaríngeas y/o bucofaringeas, que se sometieron a pruebas del virus de la gripe. Entre 2009 y 2014 se detectaron 177 718 casos de fiebre, 25 809 (14,5%) de los cuales se clasificaron como casos de enfermedades similares a la gripe. De las 9 192 muestras de pacientes con enfermedades similares a la gripe sometidas a pruebas del virus de la gripe, 3 573 (38,9%) resultaron positivas. La calidad de los datos para todos los indicadores evaluados se categorizó como superior al 90% y el sistema también parecía ser sólido en cuanto a su aceptación, simplicidad y estabilidad. No obstante, la recogida de muestras necesitaba mejorar.

Lecciones aprendidas El sistema de vigilancia de la gripe en Madagascar obtuvo buenos resultados y ofreció información fiable y oportuna para las intervenciones de salud pública. Dada su flexibilidad y el costo moderado general, este sistema podría convertirse en una plataforma útil para la vigilancia sindrómica y en laboratorios en otros entornos con pocos recursos.

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