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## Short message service sentinel surveillance of influenza-like illness in Madagascar, 2008–2012

Soatiana Rajatonirina,<sup>a</sup> Jean-Michel Heraud,<sup>b</sup> Laurence Randrianasolo,<sup>a</sup> Arnaud Orelle,<sup>b</sup> Norosoa Harline Razanajatovo,<sup>b</sup> Yolande Nirina Raelina,<sup>c</sup> Lisette Ravolomanana,<sup>c</sup> Fanjasoa Rakotomanana,<sup>a</sup> Robinson Ramanjato,<sup>c</sup> Armand Eugène Randrianarivo-Solofoniaina<sup>c</sup> & Vincent Richard<sup>d</sup>

**Problem** The revision of the International Health Regulations (IHR) and the threat of influenza pandemics and other disease outbreaks with a major impact on developing countries have prompted bolstered surveillance capacity, particularly in low-resource settings.

**Approach** Surveillance tools with well-timed, validated data are necessary to strengthen disease surveillance. In 2007 Madagascar implemented a sentinel surveillance system for influenza-like illness (ILI) based on data collected from sentinel general practitioners.

**Setting** Before 2007, Madagascar's disease surveillance was based on the passive collection and reporting of data aggregated weekly or monthly. The system did not allow for the early identification of outbreaks or unexpected increases in disease incidence.

**Relevant changes** An innovative case reporting system based on the use of cell phones was launched in March 2007. Encrypted short message service, which costs less than 2 United States dollars per month per health centre, is now being used by sentinel general practitioners for the daily reporting of cases of fever and ILI seen in their practices. To validate the daily data, practitioners also report epidemiological and clinical data (e.g. new febrile patient's sex, age, visit date, symptoms) weekly to the epidemiologists on the research team using special patient forms.

**Lessons learnt** Madagascar's sentinel ILI surveillance system represents the country's first nationwide "real-time" surveillance system. It has proved the feasibility of improving disease surveillance capacity through innovative systems despite resource constraints. This type of syndromic surveillance can detect unexpected increases in the incidence of ILI and other syndromic illnesses.

Abstracts in [عربي](#), [中文](#), [Français](#), [Русский](#) and [Español](#) at the end of each article.

### Introduction

Four years after the revised International Health Regulations (IHR) went into effect and amidst fears that influenza pandemics and other disease outbreaks could seriously threaten the health of entire populations in developing countries, it became necessary to bolster surveillance capacity, particularly in low-resource settings.<sup>1</sup> This was especially important in such settings because they generally lack the health-care infrastructure, laboratory diagnostic capability and number of physicians needed to effectively control emerging epidemic-prone diseases.

The circulation of the highly pathogenic avian influenza A(H5N1) virus in humans and animals in Asia, Europe and Africa since 2006 has raised fears of the possible emergence of a highly pathogenic pandemic influenza strain.<sup>2</sup> This has prompted many developing countries to establish surveillance systems for the early detection of the emergence and/or circulation of potential pandemic influenza strains.

Madagascar's disease surveillance systems have traditionally relied on the passive collection and reporting of data aggregated weekly or monthly. Such systems cannot detect incipient disease clusters for prompt investigation and response. In addition, diagnostic capacity outside the capital city is limited and delays in identifying the causal agents of disease outbreaks have often resulted in an inability to launch an appropriate public health response. Madagascar needed a surveillance system that could quickly identify aberrant

patterns of disease activity rather than depend exclusively on case confirmation.

### Approach

In March 2007 Madagascar's Ministry of Health, in collaboration with the Institut Pasteur of Madagascar (IPM), launched a sentinel surveillance system designed to detect incipient disease outbreaks through daily collection of syndromic case data in sentinel health centres,<sup>3</sup> backed by biological surveillance (e.g. collection and testing of biological specimens) at selected sentinel sites.

### Management team

The first step in creating the sentinel network was to identify appropriate stakeholders. A steering committee was established with epidemiologists, virologists and managers from the Ministry of Health's epidemiological surveillance service (*Direction de la Veille sanitaire et de la Surveillance épidémiologique*, DVSSE) and emerging and neglected disease control units (*Direction des Urgences et de la Lutte contre les Maladies Négligées*, DULMN). Next, regional health department and district managers were brought into the discussions surrounding the selection of potential sentinel centres.

### Sentinel centres

The sentinel network in Madagascar, which is a large island, began with 6 sentinel sites in 2007 and had expanded to 34

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by 2011. Expansion was intended to improve geographic coverage and representativeness and to make it possible to monitor epidemiologic trends in different climate zones.

Sentinel sites are primary health-care centres that are selected on the basis of several criteria, including the presence of at least two general practitioners, the availability of a mobile phone network, and the degree of commitment to actively participate in surveillance activity. Participation is entirely voluntary. Sentinel general practitioners (SGPs) serving on a gratuitous, voluntary basis are the backbone of the system, which currently covers about 8% of the Malagasy population.

### Data source

To assess the functioning of the surveillance system, we collected data from sentinel general practitioners from 1 January 2008 to 31 January 2012. All patients seen at the sentinel centres were systematically screened by each practitioner, who reported the number of cases that met the case definitions (described later) and the total number of patient visits on each reporting day.

### Data transmission

Sentinel general practitioners were expected to transmit encrypted data via cellular telephone (encrypted short message service, SMS) at least once a day, from Monday to Friday, despite occasional clinic closures resulting from routine weekday and weekend schedules. Active data collection was also carried out: if data from a sentinel centre were not received by 10:00 on a particular day, IPM staff would contact the sentinel centre to obtain the missing data.

The monthly cost of data transmission per centre was less than 2 United States dollars (US\$).

### Case definitions

Standard WHO case definitions were used for comparability. Fever (an axillary temperature  $\geq 37.5$  °C) was the first syndromic symptom targeted. Three febrile illnesses were selected for surveillance: malaria (only confirmed cases), influenza-like illness (ILI) and arbovirus infection. Cases were defined as follows: malaria, fever plus a positive result on the rapid diagnostic test; ILI, fever with a cough and sore throat; arbovirus infection, fever without respiratory

symptoms plus at least two of the following: headache, arthralgia, myalgia-like backache, skin rash, retro-orbital pain, haemorrhage. Diarrhoea syndrome was defined as three or more abnormally loose stools during the previous 48 hours. A malaria rapid diagnostic test was performed on every febrile patient with the kit provided by the national malaria programme.

### Daily analysis

Data were available for analysis shortly after each patient's initial visit. The data obtained daily from the SMS were entered into a specifically designed MS Access® database as soon as they arrived at the IPM. Thus, the turnaround time between data collection and receipt of the data, even from remote areas, never exceeded 24 hours. The data received through the SMS system included sentinel site code, date of data collection, number of outpatient consultations, number of malaria cases, ILI, dengue-like illness and diarrhoea, and number of consultations by age group.

Data were checked for variation from day to day. Analyses of temporal distribution were conducted at each sentinel centre for each syndrome category of interest. Hence, various health service-based indicators were monitored daily. They included the percentage of cases with fever, confirmed malaria, ILI and suspected arbovirus infection, as well as the percentage of diarrhoea cases with and without fever.

Surveillance data were analysed and presented using easy-to-interpret tables and graphs that illustrated the number of cases of each syndrome under surveillance. In addition, a daily and weekly baseline (i.e. average number of cases in the previous years) was calculated for each syndrome and plotted against current observations to identify aberrant patterns. Increases were reported immediately by telephone to the Ministry of Health to monitor events and response and decide whether to initiate an outbreak investigation. The first step in any outbreak investigation was to confirm the signals before responding to an epidemic.

### Validation

SGPs reported information on each patient visit and listed every new febrile patient's chief complaint or symptoms on a special paper form sent weekly to the IPM. The staff of the IPM was

therefore able to validate all information previously sent via mobile phone.

### Reporting

An external report summarizing weekly and monthly trends in centre activity were distributed to state and regional health staff and was shared with participating SGPs.

### Results

The data collected daily over the study period from the 34 sentinel centres corresponded to 862 585 patient visits. Overall, 86.7% of the data were transmitted within 24 hours.

A total of 95 401 cases (11.1%) presented with fever. The special form was completed for 80 691 of these patients (84.6%). The male to female ratio among patients with a fever syndrome was 0.89:1. Age was available for 79 651 patients (98.7%). The mean age was 12.8 years (95% confidence interval, CI: 12.7–12.9).

ILI accounted for 20 933 (21.9%) of all cases of febrile illness.

### Discussion

The results obtained by the sentinel surveillance network in Madagascar are in accordance with the aim pursued by the country's Ministry of Health. Sentinel surveillance systems offer advantages over passive surveillance, which is limited by incomplete reporting.<sup>4,5</sup> They provide a way to overcome the coverage limitations inherent in the passive surveillance of disease. However, efficient and accurate sentinel surveillance systems need to rely on strong communication systems.

A "real-time" sentinel surveillance system may be essential for the detection of infectious disease outbreaks and the launching of a prompt public health response (Box 1). The advantage of using syndromic data for outbreak detection lies in the speed with which a response can be launched.<sup>6,7</sup> Mobile phone technology, which is cheap and universally available, has been recognized as a useful tool in health care.<sup>8</sup> However, published studies on mobile phone use in health-care settings have been conducted almost exclusively in countries where a shortage of resources and the need to provide care in remote locations are the main reasons for using mobile phones.<sup>9</sup> The cost of transmitting data

**Box 1. Summary of main lessons learnt**

- Daily syndromic surveillance using SMS can effectively enhance traditional public health surveillance systems already in place.
- Combined biological surveillance and syndromic surveillance using SMS makes it possible to rapidly detect the circulation of the influenza virus in areas under surveillance.
- By detecting unusual patterns of disease activity, sentinel surveillance using SMS can quicken the response to disease outbreaks.

SMS, short message service.

on a daily basis in Madagascar's sentinel surveillance network is minimal; it costs less than US\$ 2 per month per sentinel centre, and each centre's mobile phone equipment costs a mere US\$ 10. However, the costs of maintaining the system need to be more accurately estimated, both in terms of monetary expense and the person-hours involved in responding to system alerts. Although the Ministry of Health endorses sentinel general practitioners' voluntary participation, some practitioners are asking for incentives. Motivation has been maintained not through monetary payment but through the provision of medical equipment and training opportunities, including an annual epidemiology work-

shop and an annual meeting of staff in all sentinel sites. We have noted high staff turnover and, to address the problem, health district officers are being trained to train and supervise new staff.

In conclusion, the sentinel surveillance network would not be effective without the active participation of the SGPs. Other African countries would benefit from a similar programme, both in terms of improved disease surveillance and better public health decision-making. ■

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**Competing interests:** None declared.

**ملخص**

الترصد المخفري للاعتلالات الشبيهة بالأنفلونزا في مدغشقر باستخدام خدمة الرسائل القصيرة، في الفترة من 2008-2012 الرسائل القصيرة المشفرة التي تقل تكلفتها عن دولارين أمريكيين في الشهر لكل مركز صحي لتقديم التقارير اليومية عن حالات الحمى والاعتلالات الشبيهة بالأنفلونزا (ILI) التي يلاحظونها في ممارساتهم. وللتحقق من البيانات اليومية، يقوم الممارسون أيضاً بتقديم تقارير عن البيانات الوبائية والسريية (أي جنس المريض الجديد المحموم وعمره وتاريخ زيارته وأعراضه) أسبوعياً إلى أخصائيي الوبائيات ضمن فريق الأبحاث باستخدام نماذج خاصة للمرضى.

الدروس المستفادة يمثل نظام الترصد المخفري للاعتلالات الشبيهة بالأنفلونزا (ILI) في مدغشقر أول نظام ترصد في "الوقت الحقيقي" على الصعيد الوطني في البلد. وقد أثبت جدوى تحسين قدرات ترصد الأمراض من خلال نظم مبتكرة برغم قيود الموارد. يستطيع هذا النوع من ترصد المتلازمات اكتشاف الزيادات غير المتوقعة في حدوث الاعتلالات الشبيهة بالأنفلونزا (ILI) والأمراض المتلازمة الأخرى.

المشكلة عززت مراجعة اللوائح الصحية الدولية (IHR) والتهديد الذي تمثله جوائح الأنفلونزا وفاشيات الأمراض الأخرى ذات التأثير الكبير على البلدان النامية من قدرات الترصد، وبالأخص في المواقع منخفضة الموارد.

الأسلوب تعتبر أدوات الترصد ذات البيانات التي تم التثبيت منها وذات التوقيت الجيد ضرورية لتعزيز ترصد الأمراض. وفي عام 2007، نفذت مدغشقر نظاماً للترصد المخفري للاعتلالات الشبيهة بالأنفلونزا (ILI) بناءً على البيانات التي تم جمعها من الممارسين العاميين المخفريين.

المواقع المحلية قبل عام 2007، كان ترصد الأمراض في مدغشقر يعتمد على أسلوب الجمع السلبي والإبلاغ عن البيانات التي يتم تجميعها أسبوعياً أو شهرياً. ولم يسمح النظام بالتعرف المبكر على الفاشيات أو الزيادات غير المتوقعة في معدل حدوث الأمراض.

التغيرات ذات الصلة تم إطلاق نظام مبتكر لتقديم التقارير حول الحالات بالاعتماد على استخدام الهواتف الخلوية في مارس 2007. ويستخدم الآن الممارسون العاميون المخفريون خدمة

## 摘要

### 2008年-2012年马达加斯加流感样疾病短信服务哨点监测

**问题** 《国际卫生条例 (IHR)》的修订, 以及流感大流行和其他对发展中国家有重大影响的疾病暴发的威胁, 都促使人们加强监测能力, 尤其是资源缺乏环境中的监测能力。

**方法** 加强疾病监测需要监测工具拥有及时有效的数据。在 2007 年, 马达加斯加实施了一个流感样疾病 (ILI) 哨点监测系统, 这个系统的基础是从哨点全科医生那里采集的数据。

**当地状况** 在 2007 年之前, 马达加斯加的疾病监测根据的是每周或每月汇总数据的被动采集和报告。系统无法实现疫情或疾病发病率意外上升的提早识别。

**相关变化** 2007 年 3 月, 推出一种使用手机的创新病例报告系统。加密短信服务的费用为每个卫生中心每月低于 2 美元, 正被哨点全科医生用于在他们行医期间所看到发热和 ILI 病例的每日报告。为了验证每日数据, 医生每周还需使用特殊的患者信息表向研究小组的流行病学家报告流行病学和临床数据 (例如新发发热患者的性别、年龄、就诊日期、症状)。

**经验教训** 马达加斯加的哨点 ILI 监测系统代表了该国第一个全国性“实时”监测系统。这个系统证明了通过创新系统克服资源局限提高疾病监测能力的可行性。这类症状监测可发现 ILI 和其他综合征疾病的发病率意外上升。

## Résumé

### Surveillance électronique des maladies de type grippal à Madagascar, 2008-2012

**Problème** La révision des Règlements sanitaires internationaux (RSI) et la menace de pandémies de grippe et d'accès d'autres maladies ayant un impact majeur sur les pays en voie de développement ont poussé au renforcement de la capacité de surveillance, en particulier dans les milieux à faible revenu.

**Approche** Des outils de surveillance munis de données opportunes et validées sont nécessaires pour renforcer la surveillance des maladies. En 2007, Madagascar a mis en place un système de surveillance sentinelle des maladies de type grippal (MTG), basé sur les données collectées chez des médecins généralistes de type sentinelle.

**Environnement local** Avant 2007, la surveillance des maladies à Madagascar reposait sur la collecte et la transmission passives de données collectées sur une base hebdomadaire ou mensuelle. Le système ne permettait pas de déceler de façon précoce les épidémies ou les augmentations imprévues de l'incidence de maladie.

**Changements significatifs** Un système de transmission des cas novateur et basé sur l'utilisation des téléphones portables a été lancé

en mars 2007. Le service SMS (short message service) chiffré, qui coûte moins de 2 dollars américains par mois par centre de santé, est désormais utilisé par les médecins généralistes de type sentinelle pour le compte rendu quotidien des cas de fièvre et de MTG diagnostiqués dans leur cabinet. Pour valider les données quotidiennes, les médecins font également un compte rendu hebdomadaire des données épidémiologiques et cliniques (par exemple, le sexe, l'âge, la date de consultation et les symptômes d'un nouveau patient atteint de fièvre) aux épidémiologistes de l'équipe de recherche, au moyen de formulaires patient spéciaux.

**Leçons tirées** Le système de surveillance sentinelle des MTG à Madagascar représente le premier système de surveillance à l'échelle nationale et "en temps réel" du pays. Il a prouvé qu'il était possible d'améliorer la capacité de surveillance des maladies à travers des systèmes novateurs et malgré les limitations des ressources. Ce type de surveillance syndromique permet de détecter les augmentations imprévues de l'incidence des MTG et des autres maladies syndromiques.

## Резюме

### Дозорный эпидемиологический надзор над гриппоподобными заболеваниями посредством службы коротких сообщений в республике Мадагаскар в 2008–2012 годах

**Проблема** Пересмотр международных медико-санитарных правил (ММСП), а также угроза пандемий гриппа и вспышек других заболеваний с основным ударом по развивающимся странам стали причинами уделения большего внимания надзору, особенно в условиях ограниченных ресурсов.

**Подход** Для усиления надзора за заболеваниями необходим соответствующий инструментарий и своевременные подтвержденные данные. В 2007 г. республика Мадагаскар внедрила систему дозорного эпидемиологического надзора над гриппоподобными заболеваниями (ГПЗ) на основе данных, собранных от наблюдателей-врачей общей практики.

**Местные условия** До 2007 г. эпидемиологический надзор республики Мадагаскар базировался на пассивном сборе и протоколировании сгруппированных еженедельно или ежемесячно данных. При такой системе раннее распознавание вспышек заболеваний либо внезапного роста заболеваемости было невозможным.

**Осуществленные перемены** В марте 2007 г. была запущена передовая система регистрации случаев заболевания, основанная на применении мобильных телефонов. В настоящее

время врачи общей практики-наблюдатели для ежедневного сообщения о наблюдающихся в их практике случаях лихорадки или ГПЗ применяют службу зашифрованных коротких сообщений, использование которой обходится медицинскому центру менее 2 долларов США в месяц. Для подтверждения ежедневных данных практикующие врачи еженедельно сообщают эпидемиологам исследовательской группы также эпидемиологические и клинические данные (например, пол, возраст, перечень симптомов пациента с симптомами лихорадки и дату его посещения), используя для этого специальные анкеты пациента.

**Выводы** Система дозорного эпидемиологического надзора над ГПЗ республики Мадагаскар представляет собой первую общенациональную систему эпидемиологического надзора "реального времени" в этой стране. Она доказала возможность укрепления потенциала надзора над заболеваниями с помощью инновационных систем, несмотря на ограниченность ресурсов. Данный тип синдромного надзора способен обнаружить внезапные увеличения заболеваемости ГПЗ и другими синдромными заболеваниями.

## Resumen

### Servicio de vigilancia centinela de una enfermedad similar a la gripe con mensajes cortos en Madagascar, 2008–2012

**Situación** La revisión del Reglamento Sanitario Internacional (RSI) y la amenaza de las pandemias de gripe y otros brotes de enfermedades con gran impacto en los países en desarrollo han motivado un refuerzo de la capacidad de vigilancia, especialmente en entornos con pocos recursos.

**Enfoque** Las herramientas de vigilancia con datos bien programados y validados son necesarias para aumentar la vigilancia de enfermedades. En 2007, Madagascar puso en práctica un sistema de vigilancia centinela para enfermedades similares a la gripe basado en datos recopilados por profesionales centinela de la salud general

**Marco regional** Antes de 2007, la vigilancia de enfermedades en Madagascar se basaba en la recopilación pasiva y comunicación de datos recogidos semanal o mensualmente. El sistema no permitía la identificación precoz de brotes ni de aumentos inesperados de la incidencia de la enfermedad.

**Cambios importantes** En marzo de 2007 se lanzó un innovador sistema de comunicación de casos basado en el uso de teléfonos móviles. Los profesionales centinela de la salud emplean actualmente el

servicio de mensajes cortos codificados, que cuesta menos de 2 dólares estadounidenses mensuales por cada centro de salud, para comunicar diariamente los casos de fiebre y de enfermedades similares a la gripe vistos en sus prácticas. Para validar los datos diarios, los profesionales de la salud también comunican semanalmente los datos epidemiológicos y clínicos (por ejemplo, sexo, edad, fecha de visita, síntomas del nuevo paciente febril) a los epidemiólogos del equipo de investigación mediante formularios especiales para los pacientes.

**Lecciones aprendidas** El sistema de vigilancia centinela de la enfermedad similar a la gripe de Madagascar es el primer sistema nacional de vigilancia “a tiempo real” del país. Se ha demostrado la viabilidad de mejorar la capacidad de vigilancia de la enfermedad mediante sistemas innovadores a pesar de las limitaciones de recursos. Este tipo de vigilancia basada en los síntomas puede detectar aumentos inesperados de la incidencia de enfermedades similares a la gripe y otras enfermedades sindrómicas.

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