Texila International Journal of Academic Research
ISSN: 2520-3088
DOI: 10.21522/TIJAR.2014.10.04.Art003

The Use of the Mobile Phone for Real-Time Notifications of Public Health Threats in Three Mali Health Districts between 2020-2021

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Abstract

The Ministry in charge of Health in Mali has decided to involve the community in the fight against public health threats using mobile phones according to WHO guidelines. In this regard, a guide and standard tools for community-based electronic surveillance have been developed and tested in a pilot phase in the Kadiolo health district. After the training of the actors (community health workers "ASC", health workers and epidemiological surveillance officers), all were equipped with telephony and data collection tools. To this end, CHWs send a coded message to health centers and districts every day. Then these messages are confirmed or invalidated by health workers through an investigation and the taking of samples for transport to the lab. The number of cases notified by CHWs via the electronic system was 1397 cases in 444 days, with 170 cases of illnesses and 1227 cases of events. This electronic early warning system enabled the notification of cases in less than 24 hours at the higher level. Also, the completeness of sending messages by district varied between [71 and 83%] and the cumulative average completeness of the three districts was around 77%. On average 72% of CHWs sent at least one message with a notification of 3.14 cases of illnesses and events per day. Mobile telephone is a suitable and less expensive means for the notification of diseases and events in real time.

Keywords: *Community health workers, Events, Diseases, Real-time notification, Mobile telephony, Community-based electronic surveillance.*

Introduction

To this end, Information and Communication Technologies (ICT), mainly mobile telephony, widespread in the world and particularly in Africa during these two decades, would be an effective means for real-time monitoring of public health threats. In the countries of French-speaking Africa, it is well used and widespread in urban areas, but very limited in rural and semi-rural areas because of the unprofitable nature due to the low income of the populations, the low electricity coverage, and the low population density according to a study on the adoption of telephony in Saharan Africa [1].

At the end of 2020, 495 million people subscribed to mobile services in sub-Saharan Africa, representing 46% of the region's population. Among them, 303 million people across sub-Saharan Africa were connected to mobile Internet, the equivalent of 28% of the population and the penetration rate will reach 50% in 2025.

Received: 29.07.2023 ***Accepted: 11.08.2023*** ***Published on: 30.10.2023***

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Digital platforms in the financial services and healthcare sectors have seen strong investor confidence and consumer interest during the pandemic. This was mainly due to social distancing measures and initiatives to support public health efforts to combat the pandemic using digital technologies [2]. To do this, several applications such as Kobo Toolbox, Open Data Kit (ODK) have been improved and integrated into the countries' health system to facilitate the collection and transmission of data to the higher level.

In Mali, since the introduction in 2002 of mobile telephony, a real enthusiasm has developed at the level of the populations (all categories combined) for this portable communication instrument. Although the country has only three mobile network operators (the operator Télécel, Moov Africa Malitel and Orange), the telecommunications sector is dynamic and growing, the Global System for Mobile Communication Association (GSMA) estimates that the rate penetration of mobile telephony in terms of the number of unique subscribers would exceed just over 60%, while the penetration rate in terms of the number of Internet connections would rise to more than 95%. This difference is explained by the large number of customers with more than one mobile phone or SIM card [4.5]. The occurrence of emerging diseases such as: Ebola, avian flu, Rift Valley fever, COVID19 have put a strain on the health system [6, 7]; in this regard, to find an adequate system for strengthening disease reporting, mobile telephony has been using. Given the multiple epidemics the country has faced, a holistic approach including "One Health" has proven more promising. Mali, in collaboration with certain partners, has implemented community-based epidemiological surveillance (CBS) to strengthen the detection and real-time notification of diseases under surveillance. Learning lessons from pilot projects [7, 8], the Ministry in charge of health in collaboration with the other key ministries of the "One Health" platform (livestock, environment, and agriculture) with the technical and financial support of certain partners has drawn up a national implementation guide. implementation of CBS with a view to harmonizing interventions for greater effectiveness and efficiency [9]. One of the major innovations of this approach is the use of mobile telephony for real-time reporting of suspected cases.

This is an evaluative study which consisted of analyzing the methodology for implementing and transmitting data on notifiable diseases by Community Health Agents "CHW" in three districts of Mali (Kadiolo, Kati and Kangaba) via the mobile phone and to understand the contribution of this approach. In addition, this assessment should guide the integration of mobile telephony in strengthening surveillance of rapidly notifying diseases.

Methodology

The real-time notification system via mobile telephony in Mali has been implemented in three districts: namely Kadiolo in the Sikasso region, which was the pilot before moving on to the extension to the health districts of Kati and Kangaba in the Koulikoro region [6].

The actors at the level of the region (Epidemiological Surveillance Officer), districts (Epidemiological Surveillance Officer and Information System Officer), health center (Centre Technical Directors) and CHWs were trained on the configuration of very simple messages and short of public health diseases and events, with the aim of facilitating the dispatch of information in a rapid manner as soon as it is available in the community. Each of the participating entities (region, district, health center, CHW site) as well as the diseases and public health events under surveillance had a unique code which makes it possible to identify them once the message has been received by the different levels (Tables I and II). Consequently, each CHW site sends via its basic telephone a coded message of the 27 diseases and events under surveillance to its

supervisor, its district, and its region daily whether it has a case or not [8, 9].

In addition, each entity was trained in the use of disease codes, simplified case definitions and telephones. Also, the agents of the districts and the regional health directorates were trained on the processing of data via Excel which generates the names and the number of cases of diseases and notified events and on the use of the ACCESS software for the storage and the analysis of the data generating graphs and curves followed by parameters such as the completeness of the SMS sent, the number of suspected cases by disease, event, health center, CHW site, district and region. Once these data have been processed and stored on ACCESS by the epidemiological surveillance officers at district level (ESO), they are shared at the hierarchical level of the health pyramid for decision-making.

Table 1. Entity Coding Model

100	**01**	**01**	**01**	**01**	**Provenance illustration: 100 01010101**
CHW code	**REGION**	**DISTRICT**	**Health area**	**VILLAGE**	
	SIKASO	**KADIOLO**	**BANANSO**	**(CHW website)**	

Source: Community-Based Epidemiological Surveillance Training Module (CBS)

Code **100** corresponds to the category of the active surveillance system carried out by CHWs, code **01** which means the first region to have benefited from CBS, **01:** the first beneficiary district, **01**: the health areas have been numbered in alphabetical order, each CHW site or village in each health area has also been coded to facilitate their recognition and data processing.

Table 2. Model for Coding Diseases and Events under Surveillance

No.	**Coded**	**Case to be notified**	**Symptoms / Signs**
Diseases under surveillance (number)			
1	**A00**	Cholera	Diarrhea with a “rice water” appearance + vomiting
2	**C060**	Yellow fever	Fever + yellow eyes
3	**A99**	Hemorrhagic fever	Fever + Bleeding
4	**A39**	Meningitis	Fever + stiff neck (adult): Fever + convulsions + bulging fontanel (infants)
5	**B05**	Measles	Fever + pimples on the body + red eyes
6	**R05**	Tuberculosis in humans	Persistent cough for more than 2 weeks.
7	**A80**	AFP	Acute Flaccid Paralysis
8	**A33**	Neonatal tetanus	Stiffness + Refusal to suckle
9	**VOC**	COVID-19	Fever, cough difficulty breathing and sore throat
10	**A05**	TIAC	The presence of one of the following symptoms/signs: Nausea, diarrhoea, vomiting, abdominal pain following a meal or drink consumed by 2 or more people
11	**BRUC**	Brucellosis	Recurrent abortion, joint swelling
12	**ANT**	Coal / Anthrax	High fever, tremor, difficulty breathing, runny nose, and diarrhea with blood
13	**GAV**	Avian Flu	Eye tearing, redness and pain, burning or itchy eyes, photophobia, cough, sore throat

14	**RGA**	Rabies in animals	Biting, aggressiveness hyper salivation paralysis
15	**DRAC**	Dracunculiasis	Person presenting or having a history of a skin lesion with the appearance of a worm
16	**TBOV**	Bovine Tuberculosis	Any domestic or wild cattle in which one or more of the following signs are found: persistent cough, weight loss and loss of appetite in animals
17	**GIR**	Rift Valley Fever	Any animal with a high number of abortions, sudden deaths in young animals under 2 weeks old
	Events under Surveillance (number)		
18	**P95**	Early neonatal death	Death of a child born alive then died during the 1st week of life
19	**P96**	Late neonatal death	Late neonatal death: death occurring between the 8th day and the 28th day of life
20	**P97**	Stillborn	Delivery of a dead child
21	**D00**	Maternal death	Woman who died during pregnancy or within 42 days of childbirth
22	**BA01**	Animal bites / scratches	Any wound caused by the teeth, scratch of an animal; (dog, cat or donkey…)
23	**PV01**	Scorpion stings	Anyone bitten by a scorpion
24	**PV02**	envenomation	Anyone bitten by a snake
25	**APM**	Animal Dead Fish	Group animal deaths without apparent causes in animals (unexplained)
26	**ECD**	Community death	Deaths of people without apparent causes (unexplained)
27	**AEV**	Other Events Under surveillance	Rumors of public health, Natural disasters, drowning, fires, malodorous odors, Nuisances caused by chemicals, Invasions of locusts, caterpillars and seed-eating birds that invade plants or crops

Source: Community-Based Epidemiological Surveillance Guide (CBS)

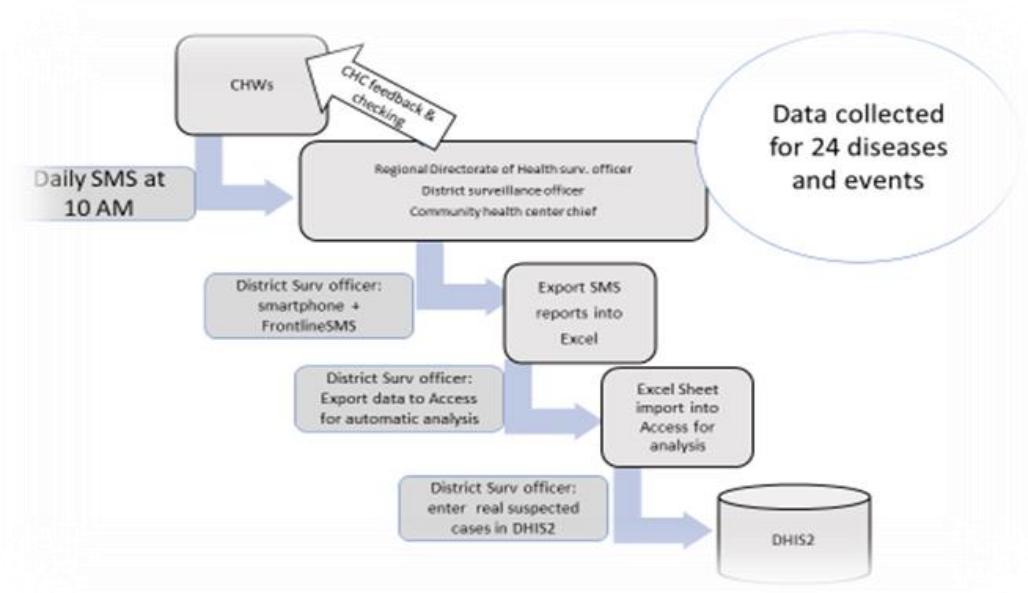
Table 3. Illustration of Coded Message Sent by the Community Health Worker

FIXED (not editable)	**VARIABLES (the numbers in red in front of the disease & event codes can be modified)**
100 01030101: example of deciphering the sending code: 100_CHW code / 01_Sikasso region / 03_Kolondièba district / 01_Bougoula health area / 01_ Zoha village	100 01030101 0A00 1C060 2A99 0A39 0B05 4R05 0A80 0A33 9COV 0A05 0BRUC 0ANT 0GAV 0RGA 0DRAC 0TBOV 0RIF 0P95 0P96 0P97 0D00 0BA01 0PV01 0 PV02 10APM 4DCE 2AEV

Source: Community-Based Epidemiological Surveillance Training Module (CBS)

The numbers 0, 1, 2, 3, define the number of suspected cases by disease and event, in case of absence of cases the number zero (0) is put to indicate that there are no cases in this village or this CHW site.

The spaces between each word and the difference between zero ' **'0'** ' and the letter '**o** " are very important (non-compliance could create problems with the processing software).



Source: Community-Based Epidemiological Surveillance Guide (CBS)

Figure 1. Message Transmission Circuit Codified

In the community, the ASC carries out the daily active search for cases, the agent sends a simultaneous coded message to all the entities no later than 10 a.m., but in the event of detection of other threats, he is required to send another message; once sent, the focal point of the health center to which he reports is responsible for verifying the information and classifying (suspect or not) then, depending on the status of the case, taking the appropriate measures including the investigation and each day the focal points of the districts are responsible for analyzing and drawing the attention of those responsible for the actions to be taken.

Results

Data was collected in the districts of Kadiolo from October 2020 to December 2021, Kati from Jan 2021 to December 2021, Kangaba from July 2021 to December 2021. In this respect, the number of agents trained: 166 CHW, 58 Health workers, 05 monitoring officers and 04 information system officer. During these different periods mentioned, the cumulative number of cases notified by the CHWs in the five districts is 1,397 cases of illnesses and events, all the cases recorded are distributed as follows: Kadiolo 744 cumulative cases including 44 cases of illnesses 700 cases of events, Kati 402 alert cases including 66 cases of illness 336 cases of events, Kangaba 251 alert cases including 60 cases of illness 191 cases of events. For the cumulative completeness of the daily sending of SMS by CHWs according to the periods mentioned above, we note a rate of 83% in Kadiolo), 71% in Kati and 76% in Kangaba.

Analysis of Collected Data

Among the **170** cases of disease notified, measles dominates with **100** cases or 58.82%, followed by tuberculosis **22** cases or 12.94%, yellow fever **17** cases or 10%, anthrax **14** cases or 8.23 % and PFA **09** cases or 5.29%. Then, of the **1227** cases of notified events, animal bites and stings dominate with **377** cases or 30.72%, followed by envenomations **339** cases or 27.62%, then neonatal deaths **320** cases or 26.07%, community deaths **126** cases or 10.26%. Kadiolo district records the highest proportion of cases (53%) followed by Kati (29%) and Kangaba. (18%).

We note that only the district of Kangaba has ≥70%. a slightly more stable data completeness rate of

Table 4. Disease Alert Cases and Events Notified in Kadiolo, Kangaba and Kati from the 4th Quarter of 2020 to the 4th Quarter of 2021

Diseases and Events		**Case notification districts**		
		Kadiolo	*Kangaba*	*Katy*
Diseases	*Cholera*	0	1	0
	Yellow fever	14	1	2
	VHF	0	0	1
	Meningitis	1	0	0
	Measles	22	55	23
	TB	3	0	19
	AFP	2	0	7
	COVID-19	1	0	0
	Anthrax Coal	0	0	14
	Avian Flu	0	1	0
	Rabies in animals	1	2	0
Events	*TIAC*	4	0	9
	Neonatal death	219	30	71
	Maternal death	1	7	10
	animal sting bite	267	31	79
	envenomation	145	28	166
	dead fish animals	1	6	1
	Community death	61	65	0
	AEV	2	24	0
Total		**744**	**251**	**402**

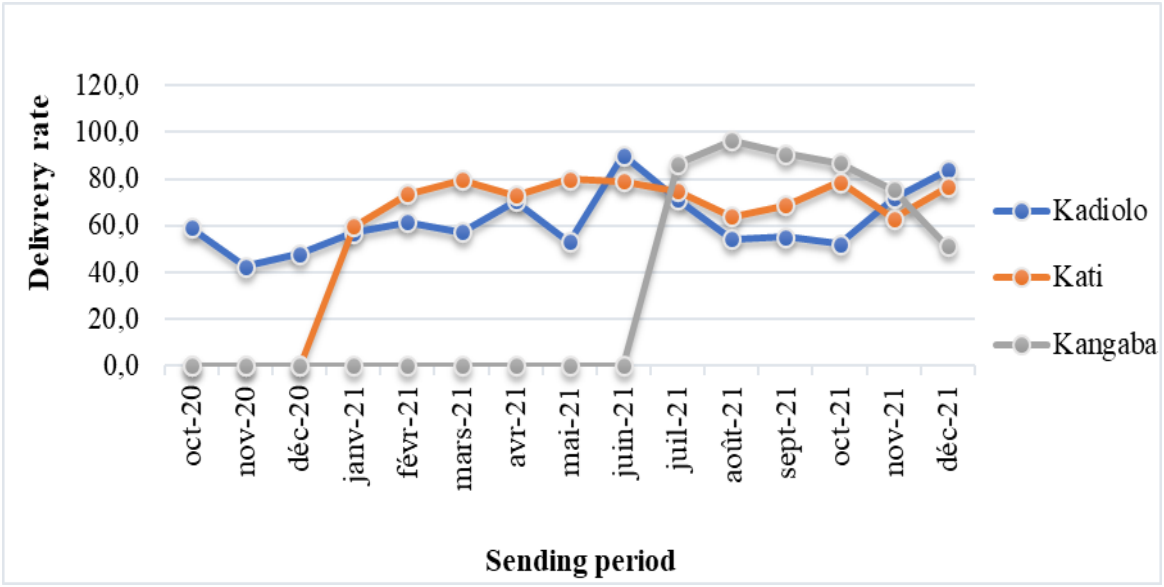


Figure 2. Evolution of the Transmission of Messages from the 4th Quarter of 2020 to the 4th Quarter of 2021 by District

Discussions and Comments

During the data collection period, the electronic community surveillance system made it possible to notify **1,397** cases, i.e., 170 cases of illness and 1,227 events in the three health districts. As for the completeness of sending messages via mobile telephony, the district of Kadiolo has the highest proportion (83%) followed by Kangaba **(76%)**; Kati **(71%)**. The electronic system made it possible to notify the above-mentioned cases in less than 24 hours to a higher level. Also, the cumulative completeness of messages sent by District varied between **[71 and 83%]** and the average cumulative completeness of the three districts was around **77%**. This implies that on average **72%** of CHWs sent at least one message during the period and with an average notification of **3.14** cases per day via the electronic approach.

The implementation of this system made it possible to revive the detection and notification of cases of diseases and events under surveillance, including by the actors who already exercised this function [8-10]. Indeed, in Kadiolo since 2018 no case of yellow fever has been notified, after the implementation of the electronic approach, an epidemic of yellow fever was notified in addition to measles and a case of AFP [11-13]. Concerning the health district of Kati two **(02)** epidemics of measles, nine (**09)** cases of food poisoning which were the subject of the investigation which made it possible to detect nearly **155** cases of collective food poisoning and seven **(07)** AFP cases have been notified. For that of Kangaba, two **(02)** epidemics of measles were notified.

In Côte d'Ivoire, similar results were reported in 2019 during the pilot phase of community surveillance in the Kabadougou region, Bafing Folon. It enabled the electronic monitoring system to detect and notify **2459** cases of illnesses and events, of which **2,062** (48%) concerned community deaths, **1,773** (42%) sick or dead animals and fish and **430** (10%) the number of other events [14].

A study in the Netherlands on the introduction of the rapid and comprehensive electronic infectious disease reporting system in 2003 compared the reporting times made in 2001 by the conventional system with those reported by the OSIRIS system in 2003. Two types of delays were compared: the total delay, defined as the time elapsed between the onset of symptoms and the declaration at the national level; and the central delay, defined as the time elapsed between the regional and national declaration. The results of the study highlighted the ability of the system to contribute to the reduction of the minimum reporting period from 10 days to 1 day. This study confirms the benefits of electronic reporting of infectious disease surveillance data in terms of timeliness and completeness. It has also documented the improvement in the timeliness and completeness of national infectious disease surveillance data that has occurred using electronic communication. Also, a study conducted in Burkina reported the benefits of the electronic approach [16].

As in our study, improved case and health event reporting was also observed during the Ebola epidemic in Guinea, which prompted WHO to integrate the community in the fight against epidemics in the country. purpose of controlling the spread of the virus. This approach has not only resulted in increased reporting, but also close monitoring, rapid case management of Ebola outbreaks and the COVID19 pandemic [17, 18]. To this end, Mali as part of the implementation of WHO guidelines has revised the third edition of its guide to integrated disease surveillance and response in accordance with WHO Afro prescriptions [19, 20]. Also in Côte d'Ivoire, according to the Saya N'Guessan study, epidemics of measles, yellow fever, avian flu and peste des petits ruminants have been reported [11]. In Senegal, Mali and Guinea, this integrated approach has further strengthened the detection and rapid containment of an epidemic of Yellow Fever and as well as a suspected case

of AFP and measles notified, also enabled the rapid and easy establishment of the "one health" approach [8-10]. Genuine pandemic preparedness and response requires replacing bi/multilateral aid and private philanthropic investments that hinder the institutionalization and professionalization of CHWs with investments made in partnership with a recipient country. These funds should be deployed quickly and flexibly according to the priorities set by the government [2 1].

Conclusion

The use of mobile telephony is an effective means for real-time notification of public health threats in its pilot phase in Mali; its extension to the community level will allow the rapid declaration of any public health threat whether human, animal, or environmental and in a global way a modeling of the "One Health" approach. It is also a less expensive way to monitor public health threats in real time. This digitization of surveillance can be extended to other areas of public health such as malaria surveillance, vaccination, maternal and child health and nutrition in all districts of Mali. Finally, other countries could also adopt it to strengthen their early warning system.

Conflict of Interest

All authors and co-authors declare that they have no conflict of interest for the work submitted.

Acknowledgements

Doctor Seydou FOMBA; PROFESSOR WIMBA KAYANGE LOUISETTE; MILABYO KYAMUSUGULWA Patrick; Professor Charles, University of Kinshasa; Professor Assob Nguedia; Professor Katembo Kambere Thaddée, Adventist University of Lukanga/DRC; General Directorate of Health and Public Hygiene of Mali (DGSHP); Regional Health Directorate (DRS) of Koulikoro and Sikasso in Mali, chief medical officers and community-based surveillance focal points in the districts of Kadiolo, Kati and Kangaba, technical directors of health centers and district community health workers.

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