Local initiatives and digitization of epidemic disease surveillance system

Case study of e-health in rural Burkina Faso

Hamidou Sanou
Assistant Professor, Dep. of Sociology and Anthropology, Université Daniel Ouezzin Coulibaly
Researcher, Laboratory GRIL, Université Joseph Ki-Zerbo, Burkina Faso
hsanou@ymail.com

Gabin Korbéogo
Professor of Sociology, Laboratory *Groupe de Recherche sur les Initiatives Locales* (GRIL), Université Joseph Ki-Zerbo, Burkina Faso
kgabin1@hotmail.com

Dan Wolf Meyrowitsch
Associate Professor and Epidemiologist, Global Health Section, Department of Public Health, University of Copenhagen, Denmark
dame@sund.ku.dk

Helle Samuelsen
Associate Professor, Department of Anthropology, University of Copenhagen, Denmark
h.samuelsen@anthro.ku.dk

How to cite this paper:
Sanou, H., Korbéogo, G., Meyrowitsch, D. W., & Samuelsen, H. (2024). Local initiatives and digitization of epidemic disease surveillance system. Case study of e-health in rural Burkina Faso. *Global Africa*, (6), pp. 196-215.
https://doi.org/10.57832/p3cd-3079

Received: August 23, 2023
Accepted: April 30, 2024
Published: June 20, 2024

Abstract

Disease surveillance is one of the areas where digital health is increasingly being applied, particularly in low-income countries. In Burkina Faso (BF), the liberalization of the telecommunications sector since 1996 has provided an opportunity for the adoption of Information and Communication Technologies (ICT) in the health sector. In 2004, the Ministry of Health and Public Hygiene (MSHP) adopted an e-health policy aimed at covering 95% of health facilities with ICT solutions by 2020. This article paid particular attention to the innovations emerging in the disease surveillance and response system (SIMR) in the face of the state's inadequate integration of ICTs into the healthcare system. More specifically, we will focus on innovations taking place in health and social promotion centers (CSPS). The study was conducted in Dandé health district in the south-western part of BF. Based on qualitative methods, data were collected through semi-structured interviews with head nurses (ICP) (n=11), Expanded Program on Immunization (EPI) managers (n=10), CISSE members (n=2) and Community-Based Health Workers (CBHWs) (n=15), as well as through observations of ICTs uses. Content qualitative analysis was performed by using concepts of tinkering and bricolage to discussing our results. With the advent of the wireless telephone, the government has tried to build a digital infrastructure, equipping the CSPSs with MoovAfrica (ex-Telmob) telephone chips and a prepaid "fleet" communication system of 5000 FCFA/month for the collection and transfer of epidemiological data called The Telegram Official Weekly Letter (TLOH). The results showed that the use of this "TLOH fleet" digital device encounters difficulties linked to the MoovAfrica telephone network signal, which is not fluid, specifically in rural localities. Other difficulties lie in the fact that the standard model of telephone acquired by the CSPSs does not have the functionalities to enable them to adapt to the challenges of call saturation on the CISSE fleet number.

As the fleet is designed for telephone calls only, it is impossible, for example, for health workers to send SMS messages or use the Internet or WhatsApp. To overcome such challenges, the majority of ICPs use their personal phones to send SMS or call CISSE's personal number(s). As these personal numbers are not registered in the fleet system, ICPs are obliged to bear the cost of calls and SMS messages. In the age of digital convergence, health workers' strategies for adapting to the new environment involve the use of smartphones and personal megadata. WhatsApp has thus become a palliative to the problem of queuing and the telephone network. Since data is sent every Monday morning until 10 a.m., ICPs prefer to use their own megadata to transfer TLOH via WhatsApp from Sunday evening onwards. Our results also show that, in addition to TLOHs, patient follow-up sheets and investigation sheets are now dematerialized via this WhatsApp application. Several WhatsApp groups (TLOH DS DANDE, INFO_CISSE DS DANDE, for example) and the CISSE manager's personal WhatsApp account are used as channels for sending data in the form of manuscript photos, Excel or Word files. All in all, our results show the extent to which state efforts are negligible in the implementation of the "e-health" policy, and thus call the attention of health authorities to the need to build a reliable public digital infrastructure that takes into account the environmental challenges of rural localities.

Keywords

Digital, health, m-Health/e-Health, Epidemic Disease Surveillance, Burkina Faso

Introduction

E-Health refers to digital systems and services in the health world (WHO, 2009). It includes medical and public health practices supported by mobile devices such as mobile phones tablets and laptops, and the practice of medicine at a distance via internet and tools such as video and electronic medical records (WHO, 2011; Bajpai, 2012; Petersson, 2014). The use of mobile devices, such as phones, tablets and laptops, to deliver healthcare services has raised hopes of a new future for healthcare in low- and middle-income countries. This promise lies in their ability to break down the barriers of time and distance to connect patients directly and more cost-effectively to healthcare systems. Digital technology also aims to make national healthcare systems more data-driven through "real-time" collection of certain health indicators (Neumark & Prince, 2021). Several mHealth innovations have been deployed to drive greater efficiency and transparency (Al Dahdah et al., 2015; Lau et al., 2020) in maternal and child health, infectious diseases, chronic diseases and mental health (Labrique et al., 2013).

Public health surveillance means "the identification, collection, grouping, systematic and continuous analysis and interpretation of data on the occurrence of disease and public health events, with the aim of taking, in a timely manner, effective measures […]" (WHO, 2019: 1). Disease surveillance is one of the areas where digital health is increasingly being applied in the wake of the Ebola epidemic in West Africa and the more recent COVID-19 pandemic (Schwamm et al., 2020; Neumark & Prince, 2021). Digital health approaches include digital communication, digital educational initiatives and digital patient management solutions, and rely on apps such as WhatsApp, Slack, Facebook, Twitter and Zoom. Such digital innovations address the need to protect vulnerable patients from the risks associated with hospitalization, promote social distances and protect healthcare staff (Kichloo et al., 2020; Robbins et al., 2020; Wood et al., 2021). The establishment of a digital surveillance infrastructure aims to provide data-driven health policy decisions to improve response to health emergencies (Al Dahdah, 2019; Ortega et al., 2020; Sittig & Singh, 2020). These technologies have also proven indispensable in the response against COVID-19 (Lau et al., 2020; Schwamm et al., 2020).

With the adoption of mobile telephony, mHealth interventions have rapidly increased in developing Countries (Blanchet et al., 2015; Meyer et al., 2020; Ojo, 2022). Research shows that African countries have become emerging grounds for mobile health approaches through projects funded by Non-Governmental Organizations (NGOs) (Poggiali, 2016; Njoroge et al., 2017; Friederici et al., 2020). These digital innovations are not necessarily inclusive or universal, although they claim to produce health outcomes in the most efficient and cost-effective way (Neumark, 2020; Prince, 2020). Despite

the optimism surrounding digital technologies for universal health coverage, there is as yet no evidence that they contribute to making national systems more robust or affordable (Friederici et al., 2020). Experiments in digital data management have even shown that mHealth projects prevent the adoption of more fundamental, proven strategies in times of public health crisis (Erikson, 2018, 2021). mHealth interventions exacerbate the financialization and privatization of the healthcare landscape, revealing the growing power of technology companies to influence the public health agenda (Al Dahdah, 2019; Storeng & de Bengy Puyvallée, 2021). In view of the challenges involved in setting up m-health projects, healthcare workers bear the costs of the "informal m-health" (Chib et al., 2014) by using, for example, their personal cell phones to render various digital services (Silva & Ben Ali, 2010; Blaschke & Lucas, 2017; Hampshire et al., 2017).

In Burkina Faso, from 1994, when fixed-line telephony was introduced, to 2001, teledensity to a telephone line remained low. The majority of telecenters (75%) were concentrated in the city of Ouagadougou alone in 1998. The telecoms access has remained worrying, despite a few attempts to set up telecentres in certain villages (Ouedraogo, 2004). Liberalization of the telecommunications sector came with the advent of mobile telephone and Internet connections in 1996 with the Moov Africa[1] network. Later, in 2000 and 2001 respectively, the Telecel[2] and Orange[3] networks were introduced (Ouedraogo, 2004). Very quickly, the indicative figures for cell phone access increased, making this the most accessible communications tool for the populations served (MENPTD, 2020).

The government's decision to introduce these mobile and digital technologies into the healthcare system was taken in 2004, following the adoption of the e-health policy. The objective of this policy, revised in 2016, was to cover 95% of health facilities with ICT solutions by 2020 (Ministry of Health and Public Hygiene (MHPH), 2016). With the advent of the Coronavirus in 2020, a study has shown that the adoption of mHealth has given rise to a flood of projects in the healthcare system since the adoption of the e-health policy. In disease surveillance (data collection, storage), for example, some of these digital innovations have been deployed against COVID-19. Most of these innovations are designed, funded and implemented by foreign donors (Map & Match, 2021). However, to our knowledge, little research has focused on this experimental terrain of *top-down* digital health projects, despite the fact that, however technically perfect, vertical innovations undergo *"an ordeal with unpredictable results, which often turns into the 'revenge of contexts'"* [4] (Olivier de Sardan, 2022: 6). In this sense, ethnographic research in the context of NGO or research center projects has shown that mobile health struggles to produce the expected results and is rescued by the adaptations of healthcare workers adopt adaptive strategies in the face of various challenges (network and Internet problems, etc.) (Sanou et al., 2016; Arnaert et al., 2019; Sawadogo et al., 2021). In view of these personal efforts, digital health is intended to be a dynamic, multifaceted phenomenon that encompasses the informal uses of digital technologies in healthcare by a patient or healthcare worker (Hampshire et al., 2021).

The surveillance of diseases with epidemical potential is carried out through individual case notification forms, descriptive case investigation forms, synthetic tables and graphs for chronological data analysis (Ministry of Health and Public Hygiene (MHPH), 2016). Epidemiological surveillance is implemented at all levels of the health system. These include the local community (through Community-Based Health Workers -CBHWs- and community leaders), peripheral health centers (through health workers such as the Head Nurse-ICP-, the Expanded Immunization Program Manager, and birth attendants and/or midwives), the health district (through the Centers for Health Information and Epidemiological Surveillance-CISSE- office and the laboratory) and the regional

1 The "Office National des Télécommunications" (ONATEL), in addition to its monopoly of the fixed-line telephone network, created "TELMOB" in 1996. In 2006, the Maroc Telecom group became a 51% shareholder in the company, and ONATEL became a public limited company (Onatel-sa). As part of this drive to privatize the telecommunications sector, Maroc Telecom increased its stake in the company to 61%. In January 2021, Onatel-sa management decided to replace the Telmob corporate identity with Moov Africa.

2 Telecel Faso is owned by the national company Planor Afrique group of Burkinabe entrepreneur Apollinaire Compaoré. Telecel Faso was created in 2000, following the liberalization of the mobile telephony market.

3 This telephone network has undergone several name changes: firstly, Celtel was renamed Zain in 2008, following the decision by the Celtel Burkina Faso SA group to create the world's first borderless intercontinental network. Then, in 2010, Zain changed its name and ownership to Airtel, a subsidiary of Bharti Airtel. Finally, Airtel became Orange in 2016 following the purchase of Airtel Burkina's shares by the French telecommunications group Orange.

4 Translation mine.

health directorate (through the regional CISSE and regional reference laboratories). Standardized definitions of suspected, probable and confirmed cases are drawn up and handed out to players according to their level of education, so that they can ensure harmonized detection and notification. However, the declaration of an epidemic is based on a certain number of notified and confirmed cases of each notifiable disease.

A single case of a disease discovered constitutes a presumption of an epidemic, requiring immediate notification, treatment of the patient, laboratory examination of blood, and investigation with a goal to identify risk factors and know the intervention measures to take. However, depending on the diseases identified, an epidemic is declared when a certain number of confirmed cases are reached within a week or a month. Only the health authority, the Ministry of Health and Public Hygiene (MHPH), has the power to declare an epidemic after analyzing the available data. Any confirmation of a case should trigger a response through measures such as emergency vaccination and education campaigns as recommended by the disease surveillance and response system (SIMR) (Ministry of Health and Public Hygiene (MHPH), 2016; Rasmussen & Sahay, 2021).

The analysis of the digital landscape in Burkina Faso's health system identified 31 digital tools, at least 18 of which have been deployed against COVID-19. Among these, the District Health Information Software 2 (DHIS2) or "line-list" (in institutional jargon) and the Laboratory Sample Traceability System (STELaB) which are implemented in the SIMR and connect health districts to regional health directorates (Map & Match, 2021). These Applications, result of partnerships with NGOs, are not yet implemented at the health and social promotion centers (CSPS) level. Regarding the connection of CSPS to health districts, it turns out that the attempts to digitize the SIMR have remained poor. In such a context, this article discusses the emergence of informal mHealth in the SIMR. It pays particular attention to how health workers are dealing with ICTs in the face of the state's inadequate insertion of technological solutions into the healthcare system in Burkina Faso. More specifically, we will focus on innovations taking place in CSPS where mHealth vertical project are implemented piecemeal, as will be seen in the results. This institutional level is the focus of the present study for several reasons: 1) CSPSs are the institutional sub-entities where surveillance is actively carried out and data is collected at the ground level of the health system; 2) it is also at this level that patient management and the response to any declared epidemic are carried out, thus generating several interactions between CSPS health workers and those of the health district.

The concepts of bricolage and tinkering in the health-care system

Technologies are instruments that makes easy the achievement of given goals. Their effectiveness depends, given the difficulties encountered in providing healthcare services, on the inventive possibilities they allow in medical practices. The use of these digital tools suggests that we use the notion of *bricolage* and *tinkering* to better characterize the innovation practices[5] of Dandé health district (DHD) health workers in a national context of fragmented mHealth implementation. According to Domínguez-Guzmán and al. (2022), bricolage refers to compensating for the not-quite-modern nature of infrastructures[6], whereas tinkering means making do with what is at hand. According to these authors, when the control for which modern technology is designed proves hard to achieve, the care given to patients takes the form of bricolage or tinkering, given the absence of information about the infrastructure.

5 Refer to Benouniche, M., Zwarteveen, M., & Kuper, M. (2014). « Bricolage as innovation: Opening the black box of drip irrigation systems. Irrigation and Drainage », 63(5), 651-658.

6 Bricolage had designated the premodern working style of others-elsewhere (Domínguez-Guzmán and al., 2020 :3). Three defining features of bricolage are identified: first, institutional, technological and ideational processes are entwined and mutually reinforcing; second, bricolage is co-produced by the State and society; and third, it is always a multi scalar process with multiple actors intervening continuously at different, connected levels. (Mayaux et al., 2023, p. 19).

These two notions refer to forms of efforts that users make when the infrastructures fail to meet the supposed modernist ideal (Mol, 2008; Domínguez-Guzmán et al., 2022). Indeed, bricolage is a creative and adaptive process which occurs through everyday adaptations in social practice[7] while adaptation means how local users learn to make equipment work (Mayaux et al., 2023). Given the ethnographic data available, the concepts of tinkering and bricolage are appropriate for exploring the reality of informal mobile health.

Research methodology

Presentation of the study area

The DHD is one of the intervention zones for this research program, in addition to the Tenkodogo health district. The DHD is located in the northern part of the Houet province and covers an area of 3,516 km². It is one of eight districts in the Hauts-Bassins health region. The DHD shares its northern border with Mali and the Banwa province (BF), and its southern border with the Do health district. The DHD is also bordered to the east by the Dafra and Léna health districts, and to the west by the N'dorola health district (Kénédougou province). The district covers six (6) rural communes out of the 13 in the Houet province, and 97 villages forming a continuum along national road no. 9 from Bobo to the Malian border. The district's population is estimated at 315,370 in 2021 (DHD, 2022).

Agriculture is their main economic activity and it is mainly based on food crops (maize, sorghum and millet), cash crops (cotton and groundnuts), extensive livestock farming (cattle, sheep, goats and pigs), etc. The epidemiological profile of the Dandé district is today dominated by the re-emergence of potential epidemic diseases such as measles and meningitis, and the emergence of dengue fever, severe acute respiratory infections (SARS) and bloody diarrhea (Sanou, 2023). Ebola and Coronavirus are other emerging diseases monitored in the DHD (DHD, 2022).

Data collection

Our research took place in 15 CSPS of the DHD. At the start of the survey, the selection criteria for the health centers were the occurrence of an epidemic[8] of measles, meningitis, yellow fever or poliomyelitis in the 5 years preceding the present study. We went to CISSE, where we analyzed statistics from 2015 to 2019. With the help of CISSE's deputy senior data manager, we went through the administrative documents (notification forms, investigation reports, etc.). Apart from the measles epidemic reported in Kimini in 2019, we did not identify any other epidemics that had occurred. In the absence of epidemics, we recorded all isolated cases of each epidemic disease by the CSPS. We selected the CSPSs of Bama, Dandé, Faramana, Kimini, Lahirasso and Samandeni, which recorded the highest number of declared and confirmed cases of epidemic diseases. Other CSPSs were added to this list, obtained using the targeted sampling technique, as new isolated cases of epidemic disease were reported during the course of the study. This purposive sampling technique enabled us to include 9 additional CSPSs where cases of measles and/or meningitis were reported.

Data were collected from December 1, 2019 to May 30, 2020. The collection of data was based on semi-structured interviews with health workers and data managers at the CISSE. The interviews focused on: the roles of the CSPS in the surveillance system, the reconfiguration of the system by ICTs, interactions in surveillance, difficulties encountered and adaptations initiated in the use of ICTs. The aim of the interviews was to obtain rich and varied responses to more or less open-ended questions (Low, 2012). Participants of the study were systematically included in the survey and included head nurses (ICP) (n=11), Expanded Program on Immunization (EPI) managers (n=10), CISSE members (n=2) and Community-Based Health Workers (CBHWs) (n=15). A total of 38 participants were interviewed. The interviews were conducted in French and recorded using a dictaphone.

7 Benouniche et al. (2014: 7) described three instances of bricolage: local users first learned how to make imported equipment work, then deconstructed drip irrigation systems and designed alternative low-cost systems, and finally selected and designed 'regular' systems.

8 An epidemic refers to the occurrence of a widespread and elevated number of cases of a particular infectious disease within a specific population or geographic area. It is characterized by a sharp increase in the number of individuals affected by the disease beyond what is normally expected (Faye et al., 2017).

The interviews were supported by direct observations of ICT use, particularly in the context of COVID-19 monitoring. The 6-month fieldwork period enabled us to observe socio-professional interactions mediated by ICTs. By adopting this heterogeneity of social science practice, we succeeded in gathering data that can serve as elements of appreciation of local initiatives to digitize the epidemic disease surveillance system put into place for the analyses carried in the DHD.

Data analysis

We analyzed our data by following the qualitative data analysis guidelines. Interviews were transcribed taking into account confidentiality issues. The first step was the organization and indexing of the data. We used content and thematic analysis methods, performing emergent coding of relevant data. This analysis allowed to group the codes under headings and formulate a general description of the research topic (Elo & Kyngas, 2008). Compelling extracts were selected, and manually analyzed by relating them to the research questions. As usual with qualitative analysis, the goal is to identify meaningful patterns and variations and not to achieve a certain representativeness (Emerson et al., 1995).

Results

Fragments and temporality of e-health adoption in Burkina Faso

The Telegram Official Weekly Letter (TLOH) refers to the data collected over the course of a week on diseases with epidemical potential, such as measles, meningitis, polio, yellow fever, etc. It is this TLOH data that enables to track the evolution of diseases by CSPS, so as not to be surprised by any epidemic.

> This is the Weekly Official Letter Telegram [...]. From Monday to Sunday, when the health units collect data on these cases, they compile them. [...] On Monday morning, before 10 a.m., they are asked to send us this data. In fact, it's epidemiological data, and we take it and pass it on to the next level up. The next higher level, which is the region, transmits this data by 10 a.m. the following Tuesday at the latest. [...]. By analyzing the TLOH, we can draw curves of diseases with epidemic potential to see where the threat is. (Substitute, CISSE of the Dandé health district).

This weekly data collection activity is carried out by the head nurses (ICP). TLOH data must be sent to the district CISSE by 10 a.m. every Monday. The fixed times of 10 a.m. and 5 p.m. for forwarding TLOH data from one institutional pole to another constitute the unit of measurement of the epidemiological indicator of promptness. Promptness, in fact, means being on time, not being late in transmission, as the principle of epidemiological surveillance establishes a range of times to be respected for each level of the healthcare system. From the CSPS to the health district, the time set as a measure of promptness is 10 a.m. From the district to the regional CISSE office, TLOHs must be transmitted, on the same Monday, by 5 p.m. at the latest. From the regional office to the MHPH, data must be sent no later than 10 a.m. on Tuesday.

So, every Monday morning, the ICPs of the 33 CSPSs in the DHD have to send their data for the previous week to the CISSE. Until the adoption of fixed-line telephones in 1994, TLHOs were transmitted by means of transport such as motorcycles. At that time, we realized that the communications revolution brought about by the advent of the landline telephone was limited to the major urban centers. Telecenters, for example, were unable to penetrate villages because of the cost of installation. The exclusion of the villages from Burkina led to disparities in disease surveillance practices, particularly in the transmission of health data. From the health districts to the health regions, TLOH data were transmitted by landline telephones, which only existed in the provincial capitals where the health districts were located.

> First, it was the landline. I know that with landlines, we used to go to telecenters and transmit. After that, cell phones became available. [...]. Otherwise, before the CSPSs were

> equipped with cell phones, you know that in Passoré, when it started, I communicated with my own cell phone. You had the choice between the telecentre or your own mobile. You go where the network is, you call. [...], only in Yako was there a landline. So all the CSPSs didn't have landlines. At the time, telephones were a luxury. Communication now with the landline, it was perhaps the district with the central level or the district with the internal service of Yako [...] but it was not towards the CSPS. (ICP, CSPS Dandé).

The CSPS health workers had to collect the data manually on scraps of paper, put fuel in motorcycles and travel to deliver them to the health districts. This road traffic for data delivery was financially costly and painful for remote CSPSs, particularly those located more than 50 km away with degraded roads, such as the CSPSs of Lahirasso, Kimini and Koroba.

> When I left school in 1986, there were no telephones. So our TLOH, telegram Official Letter, for the declaration of notifiable diseases, you take your motorcycle, you write it up and then you go back to the center to hand it over to the person in charge. (Manager, Regional EPI).

Nationwide, physical transmission experiences were not homogeneous. In the health districts where some of our interlocutors served (registered nurses who had become CSPS ICPs in the DHD or regional EPI managers), the health workers (the ICP or any other designated worker) went individually to hand over the weekly data. In other health districts, CISSE-appointed agents went round the CSPSs to collect the TLOHs. Other systems were developed, requiring CSPSs to organize themselves in such a way that the nurse in the most remote CSPS would collect data from the other CSPSs on the same axis as he progressed towards the district.

> I was head nurse. In February 1996 [...]. At the time, there was a system organized at district level. In other words, every Monday morning, there's an agent who leaves the district and goes round the health facilities to collect the TLHOs. So, he goes to each health facility, you write up your TLHO and give it to him. He brings it back to the district level in the evening and compiles it, which now informs the district level. That's the way it was in 1997-1998. It was organized in such a way that there was an agent who went round all the health facilities to collect the TLHO. It's true that each district had its own organization. In some districts, it's the head nurse of the furthest post who collects the TLHO from the other health facilities. But it's done in such a way that it's on the same axis. [...]. (Manager, Regional EPI).

According to the above, these so-called traditional communication practices even lasted until 1997-1998, while mobile telephony was adopted in 1996 in BF(Ouedraogo, 2004). In view of the importance of promptness and completeness indicators for epidemiology, at that time there was an attempt to innovate with the wired telephone system to enable CSPSs to tele-communicate with health districts. Instead of contextual adaptations based on human effort, the Ministry of Health set up the "RAC[9]", a communication system designed exclusively to enable the CSPSs furthest from the districts to be prompt in transmitting TLOHs. According to the nurses who saw the RAC without experiencing it, it was like a telecenter operating with an antenna. To this end, a CSPS was designated to house it, based on its median location in relation to the other CSPSs with which it formed an RAC circumscription.

> Back in the day, our elders knew the RAC. That wasn't easy. The RAC was a landline telephone with large antennas at the CSPS level. And to call that, I think that when you call even almost everyone on the line can hear you. So it was very complicated. And we've known health units to travel miles to transmit the TLOH. They could travel almost 55 km. To transmit TLOH in its time. That was 15-20 years ago [...]. (Substitute, CISSE Dandé health district).
>
> There was a landline in Yako, but none in the CSPSs. I know that with the telecenters that started up, there was the telecenter network first. I know that in the old days, we used to go to the telecenters to communicate data before cell phones started to appear. And there, we'd paid for our cell phones, and we used them. If there were any problems, we'd call the

9 As the analysis reveals, this communication device dates back a long time. We didn't know the meaning of the acronym.

> district with it [...] and then the CSPSs had their fleet phones. Otherwise, in the old days [...], when I went to Yako, it was only in Yako that there was a landline. So all the CSPSs didn't have landlines. At the time, telephones were a luxury. The communication now with the landline, it was perhaps the district with the central level or the district with the internal service of Yako [...]. The RAC or the fuel to come and give the TLOH. Because the RAC was not all the CSPSs as I was saying. It was the Bokin zone that had it. I think that the other CSPSs were the fuel for data transmission. When there's a campaign, we provide the fuel to go and transmit the data. There, every evening, you leave, you transmit, you come back. It was laborious. I know I was 23 km from Yako. Every evening, you have to find someone to transmit the data. […]. (ICP, CSPS Dandé).

This "phone booth" meant that nurses didn't have to travel long distances, and that they were somehow prompt in communicating TLOHs. However, conceptual limitations did little to promote the popularization and appropriation of this telephone system. For example, the RAC raised questions about the waiting time for data transmitters, who were obliged to queue up in single file, and the order of access was established according to the order of arrival of each other. RAC communication also posed the problem of correcting errors made during data transmission. Once the data had been transmitted and the nurse-transmitters returned to their CSPSs, we wondered how the receiver at the district CISSE managed to correct the erroneous data. The RAC had other conceptual limitations, such as telephone line interference between the country's different health districts. For example, the nurse at the CSPS in Dandé could find himself communicating with the CISSE in another health district.

> In the meantime, there's the RAC. The RAC system, that is, you call everyone hears. We installed this from left to right. It's like a radio. You're there, you call allo allo, voilà, voilà, and we intercept you. We take your data. I didn't personally use the RAC at the time. But when I arrived, some CSPSs had it. Apparently it's a communication device, but I don't really remember. Now, it's a device that's installed with an antenna, and when you switch it on, you start calling the Dandé health district... Since there's a lot, there's interference. If they are also concerned, they answer yes yes allo, it's the CSPS of so many. [...]. They can intercept things that don't even concern them [...]. That's the RAC. [...]. Like a radio, it's connected to a microphone. [...]. We couldn't use it. But when [...] I arrived in Yako, weren't there two of them with the RAC? Perhaps in remote areas where there were difficulties in the zone. Some of them would get together and that was that. But then it didn't go far. (ICP, CSPS Dandé).

Our respondent's comments show that the opening up of villages to the outside world was made possible by mobile telephony in the 2000s. At the time, the cost of telephone communication was *"250f CFA* "approximately 0,42 USD" *per minute"* and the price of credit cards was relatively expensive: *"it was at least 2500f "approximately 4,25 USD" because a year before it was 5000f (approximately 8,5 USD). You have to have 5000f to put in units"* (ICP, CSPS Dandé). Despite the high cost of mobile consumption and the high cost of cell phones, which were the result of a less competitive market at the time (2000-2005), some health workers had already seen the need to incorporate this technology into their professional practices, and began to monitor epidemic disease "telephonically".

> […] I know that with landlines, we used to go to telecenters and transmit. After that, cell phones became available. Now we've started equipping the CSPSs with [telephones]. Otherwise, before the CSPSs were equipped with cell phones, you know that in Passoré, when it started, I communicated with my own cell phone. You had the choice between the telecentre or your own mobile. You go where there's a network, you call the district and then you give the information. Now it's going very well. We figure it's getting better every day. Otherwise, that's the advantage. You can see that there was too much gymnastics in the past, with all the risks. First of all, it was expensive, and then there was all the risk that someone would take. (ICP, CSPS Dandé).

The dynamism of the telephone market has resulted in a drop in the cost of calls to 100 FCFA (approximately 0,17 USD) /mn and prices for handsets (standard model telephone) to 25,000 (approximately 42,5 USD), 10,000 (approximately 17 USD) and even 5,000 FCFA (approximately 8,5 USD). As a result, most of our interviewees now own at least two phones (standard and smartphones): "*We have small phones as well as our androids*" (ICP, CSPS Samandeni). This popularization of the cell phone by a more competitive market has led almost all nurses to put their personal cell phones at the service of health services. Initially, the mobile means of transferring TLOH were calls and messages (SMS). All ICPs needed was credit to call or send this weekly data by SMS.

> It was really essential because transmission [...] requires communication. If we don't communicate, I can't transmit because distance is complicated. From Kimini-Dandé, there and back, it's 180 km. Imagine every evening, I take my motorcycle to go and transmit the data. [...]. With the phone, it's fast. I just call. It saves us time, it's less tiring. (ICP, CSPS Kimini).

> Imagine today without a phone. Ah! because everything now depends on it. I know that before, when we started working [...], there were no phones like that. The fleet didn't. We used to put fuel in a motorcycle so that someone could go and deliver the TLOH every Monday morning. [...]. So it was more expensive. Imagine 5000 FCFA a month, whereas someone in Banwali, if he has to put in fuel every Monday morning to come and transmit the TLOH data [...]. As you can see, things have changed. (ICP, CSPS Dandé).

According to our respondents, the use of their personal telephones to carry out TLOH transactions, enabled them not only to avoid the risks associated with the road, but also to save and rationalize CSPS resources. These individual practices eventually inspired the Ministry of Health's "communication network for health data transmission" project. This initiative was undertaken with the support of the ''Programme d'appui au développement sanitaire (PADS)''. As part of the implementation of this communication network, the PADS has equipped health establishments with telephone chips and subscriptions to the prepaid call system. This free call system, called "a national fleet" by some nurses, means that health workers don't have to pay for telephone consumption when transmitting their health data.

> This is the telephone. Each CSPS has its own fleet, and the COGES manages the department's fleet. In the beginning, it was the PADS. This budget was charged to PADS. Now it's at the expense of the COGES. (ICP, CSPS Kimini).

According to this respondent, the CSPSs did not receive cell phones to insert SIM cards for the prepaid fleet. It was the ''Comité de Gestion des Centres de Santé (COGES)'' that bought the phones for them. Moreover, it is clear from the above interview extract that PADS bore the costs of subscribing to the fleet for some time, and when these costs became unbearable, the Ministry of Health had to recommend to the COGES that they bear the costs of prepaid telephone consumption, which amount to 5000 FCFA (approximately 8,5 USD) /month. The contract for the fleet is with the telephone operator *MoovAfrica*. The phones used are of the standard type with a single chip, and the fleet operates exclusively by telephone calls, which means it cannot send SMS. Since these phones are reserved for the Telegram Official Weekly Letter, health workers refer to them as "TLOH phones", "TLOH fleet" or "green numbers".

In addition to the purchase of telephones, CSPSs are authorized to undertake other projects to modernize their working environment, by taking financial resources from the profits generated by the pricing of health care procedures. In order to do so, the COGES must obtain the approval of the district management team (Equipe cadre du district, ECD) before executing any expenditure exceeding 25,000 FCFA (approximately 42,5 USD). During our fieldwork, we observed that the Dandé CSPS had been able to purchase a computer and printer.

> It's the SMC. We made a request to the district. They really approved and then the COGES bought this: the computer. Then came the printer [...]. According to the COGES rules, when you want to spend more than 25,000 francs, you have to submit a request to the hierarchy, which approves according to your financial capacity. (ICP, CSPS Dandé).

Apart from "Dandé", no other CSPS has been able to implement such projects. In fact, despite the Ministry's ambition to promote ICT solutions in the health system, CSPSs have only benefited from telephone chips since the adoption of the e-health strategy. This is also the only standard telephone that most COGESSs have been able to offer their CSPSs in the Dandé district. The TLOH telephone is even used for all other health services. However, when it comes to monitoring epidemic diseases, many medical practices require promptness and interactivity. Given the state's *absence* from the implementation of e-health policy, health workers find themselves forced to innovate with their own personal technical tools. The following section analyzes the innovations by nurses that are emerging in the epidemiological surveillance system.

Nursing innovations emerging in the TLOH management system

In view of the lack of funding for the implementation of activities as described in the e-health policy, health professionals are obliged to initiate actions enabling them to reallocate activities within the framework of TLOH management. Initially, as fleet calls are central to the weekly data transactions between the CSPSs and the district, it turns out that, due to the recurring problem of a weak network signal, some ICPs swap telephone chips to send SMS or call the CISSE's personal number(s). The numbers used belong to the ICPs. As these personal numbers are not registered in the fleet system, the ICPs are forced to bear the cost of calls and SMS messages.

> The difficulties here are communication, and the networks are as they are today. Often, there's a network problem. You know, there are TLOHs that we're often forced to use other numbers. If it happens to be the Telmob that's having problems, you have to go through other networks that aren't there [the fleet]. It's your units that you'll use to call. That's one, and two, there are also CSPSs where I don't even know what the TLOH is, they're Telmob numbers, whereas it just so happens that there are areas where there's no Telmob, it's Airtel. It's now up to ICP to find ways of calling with Airtel numbers. (ICP, CSPS Dandé).
>
> The difficulties are at the level of the hamlets of crops. I can often call my ASBC 5 times in a day without being able to reach him because there's no network. But Kimini here is fine for a while. It's all the networks. But I mainly use Telmob because it's the most reliable, even if there are difficulties. In an emergency, you have to travel to see. Especially in Silgassé. (ICP, CSPS Kimini).

Such *practical standards* were observed during our fieldwork, notably at the *Centre d'information sanitaire et de surveillance épidémiologique* (CISSE). By way of illustration, on 02/12/2019, a Monday morning, at 8:48 am, we found the CISSE Substitute manager in his office. Sitting on a chair, a smartphone in his left hand, he said: *"I have until 10 a.m. to record everything and until 5 p.m. to send it to the regional level"*. He was collecting the TLOHs. He received them from the ICPs and entered them into his computer at the same time. When he noticed statistical inconsistencies, he would take a red pen to make additions or subtractions, and directly question the ICPs concerned about the errors in their calculations. Due to call saturation on the "substitute's" fleet number, some ICPs called him and others sent SMS messages to his personal number(s). The ICPs who sent the SMS messages were usually the ones who tried to call in vain because of the network or the call queue. Everyone tried to be prompt in the TLOH "tele-communication". Up to ten o'clock, when he didn't receive data from such and such a CSPS, he would call them back to collect it. He would also call back those sending the SMS to acknowledge receipt of the data sent.

> On Monday morning of the following week, each ICP [...] tries to reach the CISSE manager who has his TLOH input mask. Each ICP transmits either by call or SMS. (Substitute, CISSE of the Dandé health district).
>
> It's according to a certain number of hours. Normally no later than 10 a.m., which we pass on to the district every Monday. So, if you finish your TLOH, you arrive in the morning, you manage to work out your TLOH, you call the district or you call CISSE. Often, you have to insist. There are a lot of CSPSs. Often you have to insist two or three times. If you call him and he's on the line, you have to wait. [...]. (ICP, CSPS Dandé).

The analysis of adaptations to the absence of ICT solutions from above, implies highlighting local practices in the era of digital convergence, in a second step. WhatsApp, for example. This platform for digital communication emerged as palliative strategy to the queuing and network problem. As early as Sunday evening, ICPs with megadata are already transferring their TLOHs so as not to be "fighting" the next day just for a few minutes' phone call. Users of this medium for transferring TLOH data find it preferable to SMS, as it has a system of irrefutable proof of the receipt or non-receipt of a text sent.

> Right now, we're using telephones because, as I said, TLOH is all about transmitting information over the phone. With the ease of things, how shall I put it, even disease surveillance forms, there are times, even before the sample goes out, we fill in the investigation form, we send it by WhatsApp. We scan it and send it. And even the TLOH. People, instead of calling and starting to dictate there, they just scan the week's page that they've already filled out and send on WhatsApp. There's a group we created called TLOH. (ICP, CM Bama).

According to the ICP of the above interview extract, in addition to TLOH, several other types of epidemiological data are dematerialized via this WhatsApp technology. These include data collected on patients after the detection of an illness at the CSPS and recorded on patient follow-up sheets, and investigation-related data collected through investigation sheets[10]. The WhatsApp group *TLOH DS DANDE* mentioned above, as the name indicates, is exclusively dedicated to sending TLOH data. Observation of tele-communication interactions shows, moreover, that some ICPs send their TLOH to the personal WhatsApp account of the CISSE manager's susbtitute.

In the context of COVID-19 surveillance, this digitization of health information via WhatsApp has been practiced, and has focused, for example, on vaccine data. On July 18, 2021, in another WhatsApp group, we read the following message: "*Good evening dear ICP just to inform you that covid-19 data will now be collected at the same time as TLOH. Thank you for your efforts*" (From responsible CISSE, group INFO_CISSE DS DANDE).

Following this message, some ICPs posted their vaccination data in "INFO_CISSE DS DANDE". Having observed the virtual interactions, from 3/04/2020 (date of our membership) to 15/11/2021 (date of our withdrawal from the group), we also found that there were ICPs who were transferring their TLOHs in this WhatsApp group while it was recommended to send to the *TLOH DS DANDE* group[11], which is exclusively dedicated to sharing information linked to the health system. On the other hand, we noticed that in both groups, the data were communicated in the form of photos of manuscripts, Excel or Word files, or by transcribing the data directly. So far, we can see that the tinkering done by health workers is adaptive to the lack of smartphones provided by the state, and to the limitations of "TLOH phones", which do not allow interactants to call other numbers not registered in the free prepaid call system, nor to write messages between fleet and personal numbers. In view of these « adaptive bricolage » (Domínguez-Guzmán and al., 2020), we can describe health agents as tinkers-adaptants or tinkers-*"bricoleurs"*[12] who make-do with what is to their hands to overcome the limitations of the "TLOH fleet".

10 Generally, these forms contain the following headings: health facility of origin, patient's identity and address, vaccination status (number of doses received against the disease contracted, date of last dose of vaccine received, investigation of the case, i.e. of the said disease (date of consultation, date of notification/declaration, date of onset of rash, date of investigation, and identity of investigator), history of the disease (clinical sign, notion of travel in the 7 to 21 days prior to the rash, locality visited, hospitalization and outcome), specimen (type of specimen, date of specimen, date sent to laboratory and date received by laboratory, date sent to VPD), laboratory result (type of test performed, date results sent to VPD), final classification (confirmed by laboratory, confirmed by epidemiological link, confirmed by clinical link) and identity of investigator (surname, first name, title, address and telephone).

11 It should be pointed out that, when we asked to join this group, the CISSE manager refused categorically, because it was a matter of shared epidemiological data. As I'm not a district officer, I had no right to take part.

12 Concept used to qualify who make a bricolage (Mayaux and al., 2022; Benouniche and al., 2014).

Personal ICTs: uses in other fields of epidemiological surveillance

Our observations of what health workers actually do with technical objects show that their mobile health practices encompass almost all the other aspects of epidemiologic surveillance, including the biomedical information and knowledge that are essential to the health vigilance system. This is the case in the DHD where, instead of the technical devices provided by the state, health workers use their personal ICTs to access health news. To do so, they log on to Google or Facebook for information. These digital tools enable them to keep abreast of the epidemiological profiles of emerging diseases worldwide. As an example, until COVID-19 spread to Burkina Faso -even while the disease was raging nationally-, health workers were regularly monitoring its evolution worldwide. These information are also shared through the INFO_CISSE DS DANDE group, which remains the preferred channel for health workers to share health information.

> In the case of COVID, most of the information we got about the disease was on the Net. It's on the phone we've read, otherwise we can say that well now, it's the reliability of this information that remains to be verified. But since this is the information we have, we rely on it. We're basing ourselves on that too. When there is information, for example on COVID-19, we share it. For example, there are frequent information notes on the number of cases, the number of deaths. Every day they're out. As soon as someone receives the information, they share it with the group, and then everyone has an idea of the situation: total number of cases recorded in the country, total number of cures, total number of deaths and so on. (ICP, CM Bama).
>
> CISSE has also set up a group, as has the pharmacy, and that's the district level. But there are other groups too where I'm active and we share information. In the case of COVID, I use it especially when there's new information. We used to receive them via ICT. (ICP, CSPS Faramana).

As can be deduced from the quotes above, in view of the prevailing health insecurity due to the coronavirus, electronic communication was recommended by the Ministry of Health to its staff (information note N°2020/0386/MS/SG/DRH/SAD published in the *INFO_CISSE DS DANDE* group). According to the informants, this communication via WhatsApp induces a kind of equity of access to information, as it bypasses the geographical difficulties (distance to travel, road hazards, risk of accident) that some CSPSs encounter with traditional means of transport (motorcycle, third party interposed). Without having to travel, health workers received information notes, situation reports, notification forms on the epidemiological profile of COVID-19 in BF, and protocols for managing this global health emergency. The information received digitally from the Ministry of Health also covered the response strategy and the pandemic vaccination campaign.

Other aspects of epidemiological surveillance infiltrated by e-health practices include health monitoring and the management of people affected by detected diseases. As part of these activities, health workers need to recognize the clinical signs of epidemic diseases, be able to detect them during curative care and treat them according to management protocols. However, the level of mastery of these diseases remains (sometimes) theoretical for most health workers. In our discussions with the ICPs, it emerged that the majority of nurses serving in the DHD have only received their basic training at the National School of Public Health (ENSP) and do not have enough experience, because with the Expanded Program on Immunization (EPI), diseases with epidemical potential have become rare. In order to be able to diagnose these diseases and administer the appropriate medication to patients, some health workers are forced to seek help from a colleague or superior via teleconsultation technologies (phone calls, video calls or sending patient photos via WhatsApp), or to do Google searches on the diseases they are confronted with.

> There are photos that PCIs often throw at me on WhatsApp. For example, an ICP may suspect a case of measles, but he's not sure it's measles. To get confirmation, he takes photos of the patient and sends them to me on WhatsApp, and when I look at them, I can tell him whether it's a case of chickenpox or measles. Here's an example. At [XXX], the ICP had a child with a generalized rash. A 5-year-old [...]. Now he was afraid it might be measles. I said, "Well, if you're not sure, since you've got WhatsApp, you can take a photo

> and send it to me. I'll take a look and reassure you". And when he did, I looked and quickly realized that it wasn't a case of measles. I realized it was a case of boils. This means that some children are born in the heat, and vesicles appear on their bodies. I quickly told him it wasn't measles. (Substitute, CISSE of the Dandé health district).
>
> Take measles, for example. You can enter the name and we'll give you details about the disease, explanations, the incubation period, lots of details in any case. When I had the case, in any case, I tried to get on the Internet to find out more about the disease. On the Internet, more details are given. When I got home, I was told that it attacks the eyes. In the meantime, it changes the coloring. At school, we don't go into enough detail. We do research on other diseases. Polio, for example. Especially EPI diseases, I often go in, type in the name and they give me the details. (EPI Manager, CSPS Kimini).

Epidemiological surveillance also includes investigation in the places where epidemic diseases occur. This stage consists of visiting the homes of sick people to see if there are other contaminated persons. The investigation is accompanied by an awareness-raising campaign on the intra-residential precautions to be taken, such as "quarantining" the sick (an institutional term meaning seclusion) and prohibiting the use of sick people's objects or clothing. As part of an investigation, CBHWs take charge of community surveillance and interact with health workers. Once an epidemic disease is suspected, the epidemiological activities of these community relays include identifying the households of the sick and accompanying health workers for an initial investigation known as "primary investigation" (in institutional language). This investigation is called primary because it is carried out in the first instance by the local health actors in charge of health in the villages where the disease occurs: nurses and ASBCs. It is continuously carried out by the ASBCs in the neighborhoods until the number of suspected cases obliges the district health authorities (Médecin-chef du district-MCD-, CISSE, EPI manager) to carry out another investigation. This is done by searching consultation registers (to detect other cases of the suspected disease through clinical definitional signs) and visiting families affected by the disease, with the aim of declaring an epidemic or not. ASBCs take part in this final investigation, accompanying the investigation team in the households, sometimes acting as translators, and providing answers to certain questions, notably about the participation of mothers of infected children in the EPI. If infected children did not receive vaccines, the ASBCs would be instructed to mobilize them for catch-up sessions for doses of vaccine not received, to be organized by the CSPS. Our discursive data show that in remote localities, health workers use ICTs to interact with patients' parents and ASBCs.

> When we talk about the community, it's no longer the fleet. It becomes the personal phone you use. It's a local call to the community-based health workers in charge of the zone [...] The ASBC in charge of the zone is in the Mossi district. [...] The ASBC in charge of this zone is in the Mossi district. I call him and he comes to see the concession from time to time. [...]. This case [of measles], let's say [...] that we're giving out information on displaced people. We had to make some calls. We call him, we say "hello, there was a case that came in for consultation, can you come and see?" Or we get in touch with the person concerned if we need to. But it's the ASBC who's in charge of escorting us around the courtyard. They know more about people's homes than we do. [...]. (ICP, CSPS Samandeni).

As the quote above suggests, virtual community interactions between nurses and ASBCs, whom they describe as "their eyes and ears", are based on telephone calls, as digital convergence has not been sufficiently adopted in the villages. The use of personal telephones helps to contain the spread of a suspected disease, as it enables actions to be anticipated. However, it should be emphasized that the ASBCs do not receive telephones from the COGES. This means that, for any tele-communication with health workers, ASBCs use their own telephones and bear the cost of the calls they initiate. When they have no credit for communication, they page the health agents, who call them back, while paying the cost of telephone consumption.

> I use my own phones [...] as the ASBC don't have a fleet, [...]. If they too had a fleet, we could communicate with the CSPS fleet. My units are on my cell phone so I can contact them [...]. (EPI Officer, CSPS Lahirasso).

> "We pay our units and often even we don't have money. [...] it wasn't until January 7, 2020 that we were paid 6 months since January 2019 and there are still 6 months left". (ASBC, CSPS Kimini).

Beyond the analysis of the interview excerpts, it should be pointed out that these are only SIM cards that the ASBCs have received from the State for the transfer of their financial incentives of 20,000 FCFA (approximatively 32.11 USD). These "monthly salaries" are not even regularly paid by their employer, the State. So, whether calls or SMS are made, it turns out that the bills (units and mega-data) are borne by the health workers and to a lesser extent by the ASBCs; which further underpins the sacrifices of peripheral health players in the application of mobile health in the disease surveillance system.

> The telephone? That's how we communicate, the ASBCs, the other CSPSs. We use our own resources. The major has a fleet. The fleet itself is at district level. It's not with the base agents [the ASBCs]. (ICP, CSPS Kimini).

On the other hand, when a disease is suspected in a remote locality (a village or farming hamlet), some health workers interact telephonically with patients' relatives. All they need is their numbers to overcome the recurring time-space constraints that hamper the effectiveness of epidemiological watch strategies. This was the case in the management of measles in the family of a farmer living in a farming hamlet 2 km from the Dandé CSPS. Seven children were suspected of having contracted measles. Once the first cases had been brought to the CSPS, the telephone was used as a means of communication to inform the village and recommend that other children with measles symptoms be brought to the CSPS.

> We used the telephone to contact the parents, since apparently it was the mother who first came with the child, and we took the father's number with the mother and then contacted the father. As the father was here, we needed some information from him. Being at the CSPS, he called home to ask what the children had eaten. Who they're sleeping with. (EPI Manager, CSPS Dandé).
>
> It's the notification and then exchanging with the parents. If we need them, we call them. [...]. Exchanges can be appointments. When things aren't going well, when we need information about notebooks and so on, we call because there are children there, and we didn't have any information. We had to find the carnets, that's all. [...] we were able to trace certain children. Now he's found the notebooks, he's brought them. That's the main thing. It was in Dandé [this case of measles]. (ICP, CSPS Dandé).

Although this is the only example of the use of ICT between nurses and the population in the context of epidemiological surveillance, it is deductible that the low frequency of mobile and digital interactions between carers and cared-for is explained by the rarity of epidemic episodes. This is further justified by the fact that nurses are increasingly involving the telephone in their day-to-day provision of healthcare to the public.

> We have the ASBC numbers. They are the interface between us and the community. Often, patients go through them to reach us. In some cases, he'll say: "ah! Major: here's a case. The person is here. She's embarrassed to come. (ICP, CSPS Dandé).

So, in addition to being the eyes and ears of the health system in their communities, ASBCs also act as mediators to bring people closer to health services. These ASBCs deploy their personal telephones as telecentres in the service of community health, to facilitate contact between health workers and those seeking health services. This shared use of telephones is practiced by health workers in health centers. Generally, the phone numbers of those accompanying patients are recorded in the consultation registers. To deal with certain emergencies, health workers rescue certain companions who don't have telephones, or who have run out of call credits. These tricks for inventing community ways of appropriating ICTs make the telephone a public good instead of a private one. Such tinkering by health workers are not adaptive to the limits of a digital solutions proposed to facilitate community surveillance activities or response to a potential outbreak. Rather, they are innovative in the sense that they fill the gap left by the absence of a state digital infrastructure. Since health

workers are replacing the state by tinkering with their phones, communication credits and mega-data, this way of doing can be described as tinkering, and subsequently elevates health workers to the rank of tinkerer.

Discussion

The aim of this paper was to how mobile phones are used as part of epidemic surveillance and health care in the Dandé health district (DHD). In view of the elements of analysis, several mobile and digital communication systems personally available to health workers are applied to the surveillance of diseases with epidemical potential. These include telephones (calls and SMS), the Internet and WhatsApp. In view of the results obtained, these technologies open up new horizons for capacity-building among healthcare workers. Above all, they are transforming disease management practices by enabling caregivers to teleconsult colleagues and superiors, and to play an active role in knowledge production. Mobile health via WhatsApp, which is on the rise in the DHD, further proves that ICTs fosters the autonomy of healthcare professionals, as demonstrated by other studies(Duclos, 2013; Ngabo et al., 2012).

To discuss the results, we need to focus on the concepts of tinkering, adaptation and adaptive bricolage. Referring to the theorization bequeathed by Mol (2008), it should be said that in the context of this research, the concept of tinkering designates a heterogeneous variants of the efforts made by health workers in the process of digitizing the surveillance system for potentially epidemic diseases. Just as different from adaptation, we have seen how bricolage can be adaptive, as shown by the theorization of Domínguez-Guzmán et al. (2022).

The notion of adaptive bricolage means, in our context, that health workers have adopted alternative strategies to the technological challenges faced by the TLOH phone. Unlike adaptive bricolage, bricolage "simply" refers to the form of informal mobile health that is emerging to compensate for the state's inability to provide ICTs solutions as promised in 2016 (Ministry of Health and Public Hygiene (MHPH), 2016). Indeed, *bricolage* is the use of personal technologies to improve disease surveillance in case there is a lack of public infrastructure. Bricolage becomes adaptive when inventive mediation with personal ICTs is initiated in response to difficulties in using the infrastructures proposed by the state for optimal improvement of epidemiological surveillance.

Our surveys show that tinkering and bricolage with the telephone and WhatsApp is collectively undertaken by health workers, for the simple reason that these technologies are rooted in everyday life and fundamentally modify their working conditions. These collective tinkering or bricolage measures contribute to improve disease surveillance, but we can't identify the innovators among these collective tinkerers and *bricoleurs*.

However, in the case of the TLOH, we do know that the Ministry was the innovator before the CSPS took over financing the fleet. We also know that CISSE initiated the creation of WhatsApp groups. Given the existence of national WhatsApp groups, it's impossible to say who is behind the introduction of this medium into the healthcare system. However, we can assert with certainty that all this collective tinkering or bricolage is informal and shows the limits of financial capacity or, to put it bluntly, the lack of state will to modernize the healthcare system through ICTs. it's in this sense that we agree that bricolage is co-produced by the State and society (Benouniche et al., 2014; Mayaux et al., 2023). In disease surveillance and response, bricolage and tinkering are continuous processes with multiple players (ICP, data managers and, to a lesser extent, CBHWs) interconnected to monitor diseases and produce data at different levels of the health system in the DHD.

Regarding the health data management system, in view of the interactions observed through WhatsApp groups, we can deduce that ICTs have instituted a communication scheme that transforms TLOH transmitters and their receivers into producers of epidemiological data. The role of CSPS nurses is no longer limited to filling in paper forms, but includes a certain proactivity around digitized data. Radically modifying the "nervous system" (Nora & Minc, 1978) of epidemiological surveillance, this technology reduces the space and time lag between data collection and transfer (Ganesan et al., 2012; Matthew et al., 2007). This internet-based social media platform, WhatsApp, has thus proved

indispensable in the national response to the coronavirus. As several research studies on ICT in the pandemic context have shown, the approaches implemented are digital communication, digital educational initiatives and digital patient management solutions (Lau et al., 2020; Schwamm et al., 2020). These approaches, in the context of our research, have also addressed the need to promote social distances and protect healthcare workers (Kichloo et al., 2020; Robbins et al., 2020; Wood et al., 2021).

Although, in the meantime, the health authorities have recommended the use of ICTs for the specific management of COVID-19, our analysis shows that this was a kind of formalism, as the recommendation was not followed by any specific accompanying measures. Instead, a development partner, USAID, provided CISSE with tablets to manage COVID-19 data, but not to the health workers who collect the data at the grassroots level, who face difficulties due to distance, road conditions and so on. This testifies to the fact that experimental mobile health interventions in Africa, funded by NGOs (Friederici et al., 2020; Njoroge et al., 2017; Poggiali, 2016), are not inclusive (Neumark, 2020; Prince, 2020). This fragmentation of experimental projects is best illustrated by the RAPISMS project[13], which has equipped CSPSs with the tablets for managing pharmaceutical depots, without, for the moment, including activities linked to the surveillance of diseases with epidemical potential.

Given the fragmented nature of vertical digital projects, healthcare workers at the periphery of the healthcare system are obliged to tinker with the technological means at their disposal. As the results show, adaptations involve personal sacrifices in terms of telephone and digital Internet consumption. It emerges that what Chib and al. (2014) have termed "informal m-health" is supported by DHD nurses. This is the case of health workers who use their personal cell phones to render various digital services (Blaschke & Lucas, 2017; Hampshire et al., 2017). These informal uses of digital technologies in epidemiological surveillance show that the criticism levelled at ICTs for not being able to prove the optimism placed in them (Friederici et al., 2020) only concerns the *top-down* projects of NGOs. Instead of vertical ICT solutions, it is the personal efforts of health workers that drive the dynamics of the disease surveillance system, making it more efficient and cost-effective, and making epidemiological data more accessible. In this logic of substituting for a national e-health infrastructure, informal uses of ICT encourage the emergence of a digital culture, less formal rapid communication, immediate exchanges and cooperative working (Silva & Ben Ali, 2010).

A number of studies have looked at the appropriation of ICTs such as telephones and interactive software in Burkina Faso's healthcare system. These studies have mainly focused on vertical development projects by NGOs or research centers (Arnaert et al., 2019; Sanou et al., 2016; Sawadogo et al., 2021). However, few of the projects implemented have experimented with the use of WhatsApp. Yet our results show that it is becoming the rural digital technology that will work towards the establishment of an intelligent health information system.

Given that the digitization efforts are the personal initiative of health workers (use of personal megadata, for example), we can say that this is an alternative telemonitoring system that has been built up from actual ICT use by health workers in the Dandé health district. These "emic" telemonitoring practices are based on the mastery of digital culture and the "shared representation" (Olivier de Sardan, 1998) underlying the "non-observant" discourse and behavior of healthcare workers (Olivier de Sardan, 2022). This entrenched image of ICTs is further justified by the fact that their uses concern interactions with CBHWs and, increasingly, those with the populations benefiting from healthcare services.

Analysis of the malfunctioning of the RAC and the TLOH telephone has shown that vertical projects struggled to meet the central challenges of the healthcare system. The "ordeal of contexts" suffered by these ICTs in the DHD, from 1996 to the present day, relates to the problem of the telephone network, the low level of ICT solutions in health establishments and the dependence on the development of the digital infrastructure on external aid. The very fact that there is a gap between the *official standards of* these digital technologies and the routine practices of healthcare staff has

13 This is a pilot project currently being tested in the Dandé health district. This project was introduced in 2019 and consists of offering tablets to CSPSs; to which tablets pharmaceutical depot management software is incorporated. Monthly mega-data are offered to ICPs for data collection and transfer.

led to the emergence of an expertise in everyday life. This *contextual expertise* has enabled the DHD's CSPSs to be appreciated in the quest for the promptness and completeness indicators so dear to the integrated disease surveillance and response system (SIMR). This is the "revenge of the contexts" in which e-health engineering is embedded. This contextual revenge can be explained by the fact that nurses are critical of the day-to-day conditions of epidemiological surveillance with which they are directly familiar, and wish to innovate to compensate for the inadequacies of vertical ICT solutions (LASDEL, 2023).

This underpins the internal reforms carried out by health workers using the resources available to them personally. These internal innovations took place gradually and in line with the appropriative dynamics of communication and information technologies, and enabled *contextual innovators* to adapt to the problem of correspondence between SIM cards in the TLOH fleet and personal telephones, and to the context of insufficient and, at times, even lacking network signals. They have also enabled these "reformers from within", the health workers, to solve the problem of queuing for telephone calls and the risk of delays in the transmission of weekly data. Hence *practical standards* such as the use of smartphones and personal megadata instead of the TLOH telephone (Olivier de Sardan, 2003).

Conclusion

Our analysis shows that, in response to the state's absence in covering health facilities with ICT solutions, health workers are investing their personal technological resources to make the integrated disease surveillance and response system more efficient and cost-effective in terms of epidemiological indicators such as promptness in data transmission and completeness. These informal practices for monitoring diseases with epidemical potential thus call on the State to build a public digital infrastructure independent of the approaches of NGO projects, which have so far proved fragmented and exclusive vis-à-vis the CSPSs, which are the places for data production, active surveillance of epidemic diseases and implementation of response strategies to any epidemics that may be declared.

Even if it turns out that the State is somewhat unable to build such an infrastructure on its own, and that it needs help from technical and financial partners such as NGOs, in our opinion it should nevertheless give priority to peripheral health establishments, which face the most challenges, notably difficulties to physically access certain areas where some health districts are.

List of abbreviations

ASBC: Community-based health worker
BF: Burkina Faso
CISSE: Centres d'Information Sanitaire et de Surveillance Epidémiologique.
CSPS: Centre de Santé et de Promotion Sociale (Health and Social Promotion Centre)
DHD: Dandé Health District
EPI: Expanded Programme on Immunization
ICP: Nurse Station Manager
ICT: Information and Communication Technology
MHPH: Ministry of Health and Public Hygiene
NGO: Non-Governmental Organization
SIM: Subscriber Identity/Identification Module ("smart card")
SIMR: Surveillance Intégrée de la Maladie et la Riposte (Integrated Disease Surveillance and Response)
SMS: Short Message Service
TLOH: Telegram Official Weekly Letter (Télégramme Lettre officielle Hebdomadaire)

Declarations

Ethical approval and consent to participate

Ethical approval of this study was granted by the Ethics Committee of the Institut de Recherche en Science de la Santé (N°2019-012/MESRSI/SG/CNRST/IRSS/CEIRES) of BF. We also obtained authorization for data collection from the ministry of health. In accordance with ethical guidelines, the objectives of the study were clearly explained to participants who gave verbal consent before being interviewed. The persons who did not agree to participate, were excluded from the study. The consent that was obtained from all of the participants was oral and informed.

Authors' contributions

All of the authors participated actively in the production of this study. HS contributed to the design of the study, data collection and analysis, and drafted the initial manuscript. GK and DWM coordinated the study, contributed to the data collection and analysis. HSa contributed to the design of the study, supervision of the study, and contributed to the manuscript.

Funding

This study was funded by the Danish Ministry of Foreign Affairs (Danida grant no. 17-07-KU).

Acknowledgements

The present study is part of a research project funded by the Danish Ministry of Foreign Affairs under the title "Emerging epidemics: Improving Preparedness in Burkina Faso" (Danida Fellowship project number: 17-07-KU). We would like to thank the University of Copenhagen, the Groupe de recherche sur les initiatives locales (GRIL) at Joseph Ki-Zerbo University and the Institut de recherche en science de la santé (IRSS) for their collaboration on the program. We would also like to acknowledge the work carried out by GRIL researchers and support staff. A special mention goes to all members of the "Emerging Epidemics" research team. Finally, the authors would like to thank the interviewees who gave up their time to take part in the interviews.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Bibliography

Al Dahdah, M. (2019). *From evidence-based mobile health to market-based mobile health : Itinerary of a mobile development project (for). 44*(6), 1048-1067.

Al Dahdah, M., Desgrées Du Loû, A., & Méadel, C. (2015). *Mobile health and maternal care : A winning combination for healthcare in the developing world ? A winning combination for healthcare in the developing world? 4*(3), 225-231. http://dx.doi.org/10.1016/j.hlpt.2015.04.002.

Arnaert, A., Ponzoni, N., Sanou, H., & Nana, N. G. (2019). *Using the BELT framework to implement an mhealth pilot project for preventive screening and monitoring of pregnant women in Rural Burkina Faso, Africa.* https://doi.org/10.30953/tmt.v4.100

Bajpai, M. (2012). Telemedicine : A Review., Web MedCentral Public Health, WMC002847. 3(2), 5.

Benouniche, M., Zwarteveen, M., & Kuper, M. (2014). *Bricolage as innovation : Opening the black box of drip irrigation systems. 63*(5), 651-658.

Blanchet, K., Lewis, J. J., Pozo-Martin, F., Somé, A. S., Somda, S., Ilboudo, P., Sarrassat, S., & Consens, S. (2015). A mixed-methods protocol to evaluate the effect and cost-effectiveness of an integrated electronic diagnosis (IeDA) approach for the management of childhood illnesses in primary health structures in Burkina Faso. *Implementation Science*, *11*(1), 1-9.

Blaschke, S., & Lucas, H. (2017). Beyond Pilotitis : TakingDigital Health Interventions to the National Level in China and Uganda. *Globalization & Health*, *13*(1), 49.

Chib, A., Van Velthoven, M. H., & Car, J. (2014). mHealth Adoption in Low-Resource Environments : A Review of the Use of Mobile Healthcare in Developing Countries. *Journal of Health Communication, in press*, *20*(2), 4-34.

DHD. (2022). *Plan d'action 2022*.

Domínguez-Guzmán, C., Verzijl, A., Zwarteveen, M., & Mol, A. (2022). Caring for water in Northern Peru : On fragile infrastructures and the diverse work involved in irrigation. *Environment and Planning E: Nature and Space, 5*(4), 2153-2171.

Duclos, V. (2013). *Le soin du monde : Incursions anthropologiques dans le Pan-African e- Network Project* [Thèse de doctorat en anthropologie, Université de Montréal].

Elo, S., & Kyngas, H. (2008). *The qualitative content analysis process, J Adv Nurs, 62*, 107-115.

Emerson, R., Fretz, R., & Shaw, L. (1995). *Processing Fieldnotes : Coding and Memoing. In Writing Ethnographic Fieldnotes*.

Erikson, S. L. (2018). Cell Phones≠ Self and Other Problems with Big Data Detection and Containment during Epidemics. *Medical anthropology quarterly*, *32*(3), 315-339.

Erikson, S. L. (2021). COVID-Apps : Misdirecting Public Health Attention in a Pandemic. *Global Policy*, *12*(6), 97-100.

Faye, S. L., Ndoye, T., Desclaux, A., Eboko, F., Egrot, M., & Taverne, B. (2017). Epidémies en Afrique de l'Ouest et du centre. In *Renforcement de la recherche en sciences sociales en appui des priorités régionales du bureau Régional Afrique de l'Ouest et du centre de l'Unicef : Analyses thématiques* (IRD/UNICEF, p. 60-86).

Friederici, N., Wahome, M., & Graham, M. (2020). Digital entrepreneurship in Africa : How a continent is escaping Silicon Valley's long shadow. *The MIT Press*.

Ganesan, M., Prashant, S., & Jhunjhunwala, A. (2012). A Review on challenges in Implementing Mobile Phone Based Data Collection in Developing Countries. *Journal of Health Informatics in Developing Countries*, *6*(1).

Hampshire, K., Mwase-Vuma, T., Alemu, K., Abane, A., Munthali, A., Awoke, T., Mariwah S., Chamdimba, E., Owusu, S. A., Robson, E., Castelli, M., Shkedy, Z., Shawa, N., Abel, J., Kasim, A. (2021). Informal mhealth at Scale in Africa : Opportunities and Challenges. *World Development*, *140*, 105-257.

Hampshire, K., Porter, G., Mariwah, S., Munthali, A., Robson, E., Owusu, S. A., Abane, A., & Milner, J. (2017). Who bears the cost of « informal mhealth' ? Health-workers » cell phone practices and associated political-moral economies of care in Ghana and Malawi. *Health policy and planning*, *32*(1), 34-42.

Kichloo, A., Albosta, M., Dettloff, K., Wani, F., El-Amir, Z., Singh, J., Aljadah, M., Chakinala, R. C., Kanugula, A. K., Solanki, S., & Chugh, S. (2020). Telemedicine, the current COVID-19 pandemic and the future : A narrative review and perspectives moving forward in the USA. *Family medicine and community health*, *8*(3). doi: 10.1136/fmch-2020-000530.

Labrique, A. B., Vasudevan, L., Kochi, E., Fabricant, R., & Mehl, G. (2013). mHealth innovations as tools for strengthening health systems : 12 common applications and a visual framework. *Global health: science and practice*, *1*(2), 160-171. https://doi.org/10.9745/ghsp-d-13-00031.

LASDEL. (2023). *Ameliorer la qualite des soins & reformer et renforcer les systemes de sante « par le bas. Bilan scientifique et technique des recherches-opérationnelles du lasdel et pistes pour demain*.

Lau, J., Knudsen, J., Jackson, H., Wallach, A. B., Bouton, M., Natsui, S., Philippou, C., Karim, E., Silvestri, D. M., Avalone, L., Zaurova, M., Schatz, D., Sun, V., & Chokshi, D. A. (2020). Staying Connected In The COVID-19 Pandemic : Telehealth At The Largest Safety-Net System In The United States : A description of NYC Health+ Hospitals telehealth response to the COVID-19 pandemic. *Health Affairs*, *39*(8), 1437-1442.

Le Ministère de l'économie numérique, des postes et de la transformation digitale (MENPTD). (2020). *Annuaire statistique 2020*.

Map, & Match. (2021). *Digital health systems to support pandemic response in Burkina Faso. Mapping digital health tools and matching deployment opportunities in response to COVID-19* (p. 13).

Matthew, A. G., Currie, K. L., Ritvo, P., Nam, R., Nesbitt, M. E., Kalnin, R. W., & Trachtenberg, J. (2007). Personal digital assistant data capture : The future of quality of life measurement in prostate cancer treatment. *Journal of oncology practice*, *3*(3), 115-120. https://doi.org/10.1200/JOP.0732001

Mayaux, P. L., Dajani, M., Cleaver, F., Naouri, M., Kuper, M., & Hartani, T. (2023). Explaining societal change through bricolage : Transformations in regimes of water governance. *Environment and Planning E: Nature and Space*, *6*(4), 2654-2677.

Meyer, A. J., Armstrong-Hough, M., Babirye, D., Mark, D., Turimumahoro, P., Ayakaka, I., Haberer, J. E., Katamba, A., & Davis J. L. (2020). Implementing mHealth interventions in a resource-constrained setting : Case study from Uganda. *JMIR mHealth and uHealth*, *8*(7), e19552.

Ministry of Health and Public Hygiene (MHPH). (2016). *Cyberstratégie sectorielle eSanté 2016 – 2020*.

Mol, A. (2008). *The logic of care : Health and the problem of patient choice.* Routledge.

Neumark, T. (2020). *The Hype and Hope of Data for Healthcare in Africa.* Somatosphere.

Neumark, T., & Prince, R. J. (2021). Digital health in East Africa : Innovation, experimentation and the market. *Global Policy*, *12*(6), 65-74.

Ngabo, F., Nguimfack, J., Nwaigwe, F., Mugeni, C., Muhoza, D., Wilson, D. R., Kalach, J., Gakuba, R., Karema, C., & Binagwaho, A. (2012). Designing and Implementing an Innovative SMS-based alert system (RapidSMS-MCH) to monitor pregnancy and reduce maternal and child deaths in Rwanda. *Pan. Afr. Med. J.*, *13*, 31.

Njoroge, M., Zurovac, D., Ogara, E. A. A., Chuma, J., & Kirigia, D. (2017). Assessing the Feasibility of eHealth and mHealth : A SystematicReview and Analysis of Initiatives Implemented in Kenya. *BMC research notes*, *10*, 1-11.

Nora, S., & Minc, A. (1978). *L'informatisation de la société*.

Ojo, A. (2022). M-Health in Africa : A Situation Analysis. In *Handbook on ICT in Developing Countries* (River Publishers, p. 149-171).

Olivier de Sardan. (1998). Émique. *L'homme*, *38*(147), 151-166. https://doi.org/10.3406/hom.1998.370510

Olivier de Sardan, J. P. (2003). L'enquête socio-anthropologique de terrain : Synthèse méthodologique et recommandations à usage des étudiants. *LASDEL*, *Etudes et travaux n° 13*, 58.

Olivier de Sardan, J. P. (2022). Relying on your own strengths." Faced with aid dependency, promoting contextual experts in public policy in Africa. *Global Africa*, *1*(1), 96-111.

Ortega, G., Rodriguez, J. A., Maurer, L. R., Witt, E. E., Perez, N., Reich, A., & Bates, D. W. (2020). Telemedicine, COVID-19, and disparities : Policy implications. *Health policy and Technology*, *9*(3), 3686-6371.

Ouedraogo, S. (2004). *Analyse de la situation de la téléphonie rurale au Burkina Faso, Version 1.* Institut Panos Afrique de l'Ouest.

Petersson, J. (2014). *Geographies of eHealth : Studies of Healthcare at a Distance.* http://hdl.handle.net/2077/35674

Poggiali, L. (2016). Seeing (from) Digital Peripheries : Technology andTransparency in Kenya's Silicon Savannah. *Cultural Anthropology*, *31*(3), 387-411.

Prince, R. J. (2020). *A Politics of Numbers ? Digital Registration in Kenya's Experiments with Universal Health Coverage.* Somatosphere.

Rasmussen, S. L., & Sahay, S. (2021). *Multiplicity and temporality of rationality : Constructing information for meningitis surveillance and response in Burkina Faso*. https://doi.org/DOI: 10.1080/01972243.2021.2004567

Robbins, T., Hudson, S., Ray, P., Sankar, S., Patel, K., Randeva, H., & Arvanitis, T. N. (2020). COVID-19 : A new digital dawn? *Digital health*, *6*, 2055207620920083.

Sanou, H. (2023). *Usage des technologies de l'information et de la communication (TIC) dans le système de surveillance des maladies à potentiel épidémique dans le district sanitaire de Dandé-Burkina Faso. Logiques d'appropriation et interactions sociales*. thèse de doctorat en Sociologie, Université Joseph Ki-Zerbo, Burkina Faso.

Sanou, H., Yé, M., Duclos, V., Kagoné, M., Bicaba, B., Tinto, I., Millogo, O., Bagagnan, C., Zabré, P., Sié, A., & Bibeau, G. (2016). Notes sur le processus de mise en place d'une plateforme de santé mobile : Design, défis et perspectives à venir. *Cahiers REALISME*, *10*, 35.

Sawadogo, N. H., Sanou, H., Greene, J. A., & Duclos, V. (2021). *Promises and perils of mobile health in Burkina Faso*. *398: 738–39, numéro spécial sur la médecine sociale*. https://doi.org/10.1016/S0140-6736(21)01001-1

Schwamm, L. H., Erskine, A., & Licurse, A. (2020). A digital embrace to blunt the curve of COVID19 pandemic. *NPJ digital medicine*, *3*(1), 64.

Silva, F., & Ben Ali, A. (2010). Emergence du travail collaboratif : Nouvelles Formes d'Organisation du Travail. *Management & Avenir*, *6*, 340-365.

Sittig, D. F., & Singh, H. (2020). COVID-19 and the need for a national health information technology infrastructure. *Jama*, *323*(23), 2373-2374.

Storeng, K. T., & de Bengy Puyvallée, A. (2021). The Smartphone Pandemic : How Big Tech and Public Health Authorities Partner in the Digital Response to Covid-19. *Global Public Health*, *16*(8-9), 1482-1498.

WHO. (2009). *Telemedicine opportunities and developments in member states, report on the second global survey on ehealth, global observatory for ehealth* (Vol. 2).

WHO. (2011). mHealth : New horizons for health through mobile technologies. In *mHealth : New horizons for health through mobile technologies*.

WHO. (2019). *Technical guidelines for integrated disease surveillance and response in the African region : Third edition. Booklet One : Introduction Section*. WHO Regional Office for Africa.

Wood, B. R., Young, J. D., Abdel-Massih, R. C., McCurdy, L., Vento, T. J., Dhanireddy, S., Moyer, K. J., Siddiqui, J., & Scott, J. D. (2021). Advancing digital health equity : A policy paper of the Infectious Diseases Society of America and the HIV Medicine Association. *Clinical Infectious Diseases*, *72*(6), 913-919.