











How has Guinea learnt from the response to outbreaks? A learning health system analysis

Tamba Mina Millimouno ^{1,2}, Bruno Meessen ³, Willem Van De Put ⁴, Marlon Garcia ⁴, Bienvenu Salim Camara ¹, Aliki Christou ⁴, Therese Delvaux ⁴, Sidikiba Sidibé ^{1,2}, Abdoul Habib Beavogui ¹, Alexandre Delamou ^{1,2}

To cite: Millimouno TM, Meessen B, Put WVD, *et al*. How has Guinea learnt from the response to outbreaks? A learning health system analysis. *BMJ Global Health* 2023;**8**:e010996. doi:10.1136/bmjgh-2022-010996

Handling editor Seye Abimbola

► Additional supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/bmjgh-2022-010996>).

Received 17 October 2022
Accepted 23 January 2023



© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

¹Research Section, Centre National de Formation et de Recherche en Santé Rurale de Maferinyah, Forécariah, Guinea

²Centre d'Excellence d'Afrique pour la Prévention et le Contrôle des Maladies Transmissibles (CEA-PCMT), Conakry, Guinea

³Health Systems Governance and Financing Department, World Health Organization, Geneva, Switzerland

⁴Public Health Department, Institute of Tropical Medicine, Antwerpen, Belgium

Correspondence to

Dr Tamba Mina Millimouno; mina@maferinyah.org

ABSTRACT

Introduction Learning is a key attribute of a resilient health system and, therefore, is central to health system strengthening. The main objective of this study was to analyse how Guinea's health system has learnt from the response to outbreaks between 2014 and 2021.

Methods We used a retrospective longitudinal single embedded case study design, applying the framework conceptualised by Sheikh and Abimbola for analysing learning health systems. Data were collected employing a mixed methods systematic review carried out in March 2022 and an online survey conducted in April 2022.

Results The 70 reports included in the evidence synthesis were about the 2014–2016 Ebola virus disease (EVD), Measles, Lassa Fever, COVID-19, 2021 EVD and Marburg virus disease. The main lessons were from 2014 to 2016 EVD and included: early community engagement in the response, social mobilisation, prioritising investment in health personnel, early involvement of anthropologists, developing health infrastructure and equipment and ensuring crisis communication. They were learnt through information (research and experts' opinions), action/practice and double-loop and were progressively incorporated in the response to future outbreaks through deliberation, single-loop, double-loop and triple-loop learning. However, advanced learning aspects (learning through action, double-loop and triple-loop) were limited within the health system. Nevertheless, the health system successfully controlled COVID-19, the 2021 EVD and Marburg virus disease. Survey respondents' commonly reported that enablers were the creation of the national agency for health security and support from development partners. Barriers included cultural and political issues and lack of funding. Common recommendations included establishing a knowledge management unit within the Ministry of Health with representatives at regional and district levels, investing in human capacities and improving the governance and management system.

Conclusion Our study highlights the importance of learning. The health system performed well and achieved encouraging and better outbreak response outcomes over time with learning that occurred.

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ A growing interest in learning health systems over the past decade has led the Alliance for Health Policy and Systems Research to conceptualise a framework for analysing learning health systems, which had not yet been implemented.
- ⇒ Guinea has experienced successive and parallel infectious disease outbreaks between 2014 and 2021 that have provided learning opportunities for the health system and is, therefore, an appropriate setting to apply the learning health systems analysis framework.

WHAT THIS STUDY ADDS

- ⇒ Learning truly occurred in the response to outbreaks in Guinea's health system through—basic learning aspects (information, deliberation and single-loop learning) most often—action/practice and double-loop learning every so often—and triple-loop learning hardly ever; this learning led to improved performance of health system's response to outbreaks over time, resulting in better control of COVID-19 and a successful response to the 2021 Ebola virus disease and Marburg virus disease. Survey respondents reported enablers and barriers to learning and formulated recommendations for improvements.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Learning within Guinea's health system needs to be valued and promoted through addressing the recommendations made by study participants and researchers.
- ⇒ The framework needs to be improved to comprehensively capture learning aspects and further studies are needed to widely deploy this framework in different contexts to help scholars and practitioners better understand its practicalities and facilitate analysing learning health systems.

INTRODUCTION

Learning is key to our lives, the success of our projects, performance of organisations and flourishing of our societies. Learning occurs naturally, but it can also be optimised. There are many definitions of learning.^{1–6}

The one proposed by Fiol and Lyles, though limited by not including a behavioural change, better captures our perspective of learning—learning is the development of insights, knowledge and associations between past actions, the effectiveness of those actions, and future actions.⁵ Referring to Garvin's definition of a learning organisation,⁷ a learning health system (LHS) can be defined as a health system skilled at creating, acquiring, interpreting, transferring and retaining knowledge, and at purposefully modifying its behaviour to reflect new knowledge and insights. Over the past decade, there has been a growing interest in LHS.^{8–22} An LHS builds on the recognition that health systems are complex, adaptive and social institutions that dynamically respond and adapt to changing needs and contexts, and it also potentially has a long-term orientation towards change and transformation that goes beyond resilience.²⁰ From this perspective, learning must be prioritised as a core component of health system strengthening agendas.^{11 17 18 21 22}

Learning is essential to health system performance. An LHS can lead to more informed, critical and corrective practices and routines, resulting in improved performance of the health system's functions, increased adaptivity and innovation and greater self-reliance.^{10 20} The following examples illustrated some benefits of LHS connected with outbreak response—Several Asian countries, for example, South Korea, Singapore, Taiwan, Hong Kong, Saudi Arabia, Cambodia and Vietnam have speedily controlled COVID-19 based on learning from previous outbreaks of Middle East respiratory syndrome and/or severe acute respiratory syndrome^{23–30}—In Barbados, a learning collaboration between the Ministry of Health (MoH) and researchers was instrumental in developing a climate-sensitive and epidemiology-sensitive warning system for future dengue outbreaks³¹—In Georgia, an evidence synthesis from the experiences of the earlier-mentioned Asian countries in the successful response to COVID-19 helped health authorities to identify a set of measures for an effective response (achievement of intended goals) to this outbreak.³² In Nigeria, the establishment of vital new learning processes for outbreak control drawn on the experience from the response to Lassa fever enabled the health system to strengthen its capacity to produce the knowledge needed to tackle future outbreaks.^{33–35}

Despite the potential benefits of an LHS, many health systems in low-and middle-income countries are not always capable of effectively generating and using the knowledge they need for good performance. Reservoirs of tacit and experiential knowledge remain poorly deployed and harnessed,^{36 37} and consequently, policies and practices are often insufficiently informed by experience, data and evidence.¹⁶ Some LHS initiatives pointed out the lack of institutionalisation^{38 39} and lack of resources⁴⁰ as barriers to success and sustainability. Other barriers include the lack of shared understanding of the concept of LHS.²⁰ A health system that does not learn from its own or others' experiences tends to repeat mistakes, and this has often

resulted in the failure of well-intentioned policies and programmes.^{11 41}

In September 2021, the Alliance for Health Policy and Systems Research (AHPSR) published a report that outlines the different ways in which health systems can learn and the steps that different stakeholders (including researchers) can take to help build LHS.²⁰ In this report, the AHPSR combined three dimensions across which learning occurs in health systems grounded on the significant body of existing theories and frameworks of learning organisations and field case studies. These three dimensions are defined as learning levels (individual, team/group, organisation/cross-organisation), means of learning (information, deliberation and action/practice) and learning loops (single, double and triple).²⁰ These are intended to be a starting point for gaining a shared understanding of an LHS as an actionable agenda. As a result, the WHO called on all countries to invest in LHS since this is the surest track to strengthening health systems sustainably and to progress towards universal health coverage.³ This study, therefore, subscribes to this call to action and is, to our knowledge, one of the first (if it is not the first) to examine how the conceptual framework proposed by the Alliance for analysing LHS can be implemented.

Guinea offers an ideal setting for such research for several reasons. First, the 2014–2016 Ebola virus disease (EVD) outbreak which severely undermined Guinea's health system (3814 infected cases and 2544 deaths⁴²), provided outstanding opportunities to learn from its management for better preparedness to respond effectively to future outbreaks.^{43–45} Moreover, after the EVD outbreak, Guinea experienced several other public health crises, such as Meningitis, Measles, Yellow Fever, Lassa fever, COVID-19, circulating vaccine-derived type 2 poliovirus (cVDPV2), 2021 EVD and Marburg virus disease. However, given the heavy workload and limited resources of Guinea's MoH, the documentation of its experience (both positive and negative) in responding to health system 'shocks' has not been undertaken. This raises a few questions—Has the succession of outbreaks been a source of learning for the health system?—Was this succession of outbreaks an asset in speedily containing, for example, the 2021 EVD and the Marburg virus disease? Nevertheless, no evidence exists on how Guinea's health system has responded to and how it learnt from these public health crises and adapted its strategies and actions as a result.

Second, during the 2014–2016 EVD outbreak, an LHS intervention called 'District.Team' was initiated by experts from the Health Service Delivery Community of Practice and implemented as an action-research by the Institute of Tropical Medicine (ITM) of Antwerp (Belgium) in collaboration with its partner institutions ('Centre National de Formation et de Recherche en Santé Rurale de Maferinyah' in Guinea and 'Centre de Recherche en Reproduction Humaine et en Démographie in Benin') and piloted in Guinea and Benin in 2016–2017 with funding from

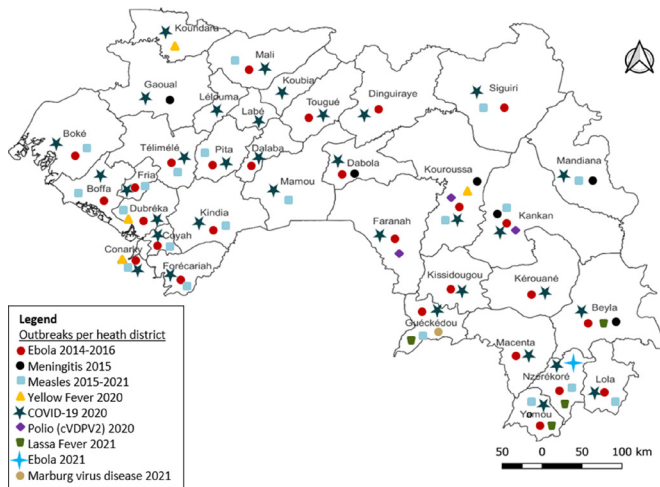


Figure 1 Outbreaks distribution in Guinea, 2014–2021.

UNICEF.^{38 46} This initiative primarily targeted District Health Management Teams (DHMTs) and later involved staff from regional and central levels in online discussions. It aimed to capacitate DHMTs through participatory evidence production and peer-to-peer exchange to respond to outbreaks and other emerging health issues. Thus, it produced learning through information, deliberation, single-loop and triple-loop, and at the individual and team levels; this learning resulted in optimising the learning capacities of DHMTs.^{20 38 46} However, there is no evidence about whether and how Guinea's health system has taken advantage of this learning initiative in responding to outbreaks that followed the 2014–2016 EVD.

Therefore, this study aimed to analyse how Guinea's health system has learnt from the response to outbreaks between 2014 and 2021. Specifically, we sought to (1) identify lessons learnt and whether and how the health system incorporated these lessons into its learning process and the response to future outbreaks, drawing on the literature, (2) describe learning that took place at different health system levels from the stakeholders' perspective, (3) determine enablers and barriers to LHS

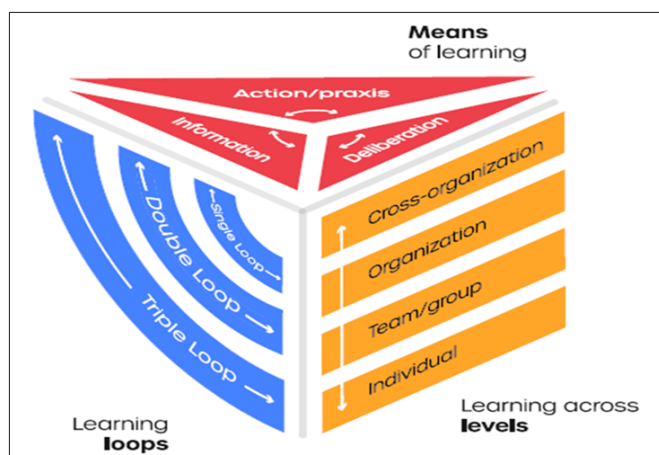


Figure 2 The three learning dimensions in health systems.²⁰

from the stakeholders' perspective and (4) formulate recommendations for improvement of learning within the health system from the perspective of stakeholders.

METHODS

Study design

We used a retrospective longitudinal single embedded case study design.⁴⁷ The *case* is defined as the *Guinea health system*. The type of case study is *retrospective longitudinal* since we aimed to document and analyse change over time (the past 8 years) and *single embedded* because we included multiple units of analysis in the same case: health committees, health districts, health regions, the MoH and its partners (different contexts and levels). The study sites were the health districts and regions in Guinea where at least one outbreak occurred within the study period. Our *theoretical proposition* is that an LHS must incorporate all the aspects of the three learning dimensions (cf. Conceptual framework).

Setting

The study was conducted in Guinea, a West African country with a population of approximately 13 million, 84% of whom live in rural areas.⁴⁸ The Guinean health system has three levels—local (38 health districts)—intermediate (eight health regions)—and central (MoH).⁴⁹ The structural organisation of the central level includes the National Agency for Health Security (ANSS), as an attached service. The ANSS, created on 4 July 2016 by presidential decree (N°:D/2016, 205/PRG/SGG)⁵⁰ after the EVD outbreak, is in charge of the prevention, surveillance and management of epidemic diseases in Guinea. It implements the strategic orientations of the MoH in terms of health security in the country.

Between 2014 and 2021, Guinea experienced several outbreaks such as EVD, Meningitis, Measles, Yellow Fever, COVID-19, cVDPV2, Lassa Fever and Marburg virus disease. Some of these outbreaks spread over all the health districts, and others affected only one or some health districts, as mapped in [figure 1](#) using the quantum geographic information system version 3.6. The two haemorrhagic fevers (EVD and Marburg virus disease) originated from the N'Zérékoré health region, where there exist two forests (Ziama and Diécké) considered among the world's last remaining primary forests.⁵¹

Conceptual framework

The framework proposed by Sheikh and Abimbola²⁰ for analysing LHS is used and contributes to ensuring the external validity or transferability of this case study.^{47 52 53} It presents three dimensions, namely levels, loops and means, whereby learning occurs in health systems. These dimensions are presented in [figure 2](#) and concisely described in [box 1](#). Their full description can be found in the flagship report accessible from the following link : <https://ahpsr.who.int/publications/i/item/learning-health-systems-pathways-to-progress>

Box 1 The three learning dimensions in health systems

Learning across levels

Learning occurs at the individual, team/group, organisation and cross-organisation levels.

Learning at an individual level entails information-gathering from different sources, gaining tacit knowledge through experience and interpreting these knowledge inputs.

Team or group-level learning tends to involve the collective interpretation of knowledge through dialogue and exchange and the development of shared understanding about issues, problems and solutions.¹⁰³

Learning at the organisation and cross-organisation levels happens when knowledge and understanding to facilitate more comprehensive coordinated action are integrated and become routine.^{103–105}

Learning loops

Theorists of learning organisations such as Argyris,⁷⁹ Argyris and Schön,^{92 106} and Tosey *et al*⁸⁶ identified three learning loops, namely single, double and triple.

Single-loop learning contributes to adjustments and corrections in regular actions—adapting routines and practices within the system without checking assumptions or underlying root causes.⁷⁹

Double-loop learning goes a step further to question and influence fundamental frameworks, mental models and assumptions around problems and their solutions, resulting in changes at the level of governing norms, policies or objectives/goals.

As for *triple-loop learning*, there is limited consensus among the scholars about its definition.⁹⁶ Nevertheless, often referring to as ‘learning how to learn’, triple-loop learning involves questioning the very basis (learning frameworks and assumptions) through which single-loop and double-loop learning occur and influencing them to change. It improves how the system learns through deliberate changes in or producing new learning structures, processes and strategies.^{79 92 106 107}

Means of learning

Crossan *et al*,¹⁰³ Stiglitz,¹⁰⁸ and Jenkin¹⁰⁹ identified three distinct and interconnected means whereby learning is produced in complex systems, namely learning through information, deliberation and action or practice.

Learning through information includes collecting, processing, deploying and disseminating information to meet the various learning aims of health systems, including measuring success and failure, anticipating trends and finding new approaches to address problems.^{110 111}

Learning through deliberation is about producing learning through acts of human deliberation.^{108 112} Processes of dialogue and reflection are essential to link past actions, the effectiveness of those actions, and future actions and consist of non-peer and peer engagements and may occur in-person or through technology-enabled platforms.^{113–115}

Learning through action in complex social systems happens when people, whether individually or as part of a team, group or organisation, learn through the practice and iteration of tasks and projects.^{116–118}

Data collection methods

Data were collected by the primary author (TMM) over 2 months, that is, March–April 2022, through a mixed methods systematic review⁵⁴ (box 2) and an online survey (box 3). The review was carried out in March 2022 and informed the survey which was conducted in April 2022 after obtaining ethical approval from ethics bodies in Guinea and at ITM. The review identified lessons from the response to each outbreak and allowed for analysing whether and how Guinea’s health system (as a whole) incorporated these lessons into its learning process and the response to future outbreaks (specific objective 1). From these general knowledge about learning from each outbreak (at the HS level), the online survey explored how each HS level (specifically) learnt over the study period (specific objective 2), determined enablers and barriers to LHS for outbreak response (objective specific 3) and provided recommendations for improvement (specific objective 4) from the stakeholders’ perspective. Therefore, both review and survey complemented each other to answer the research question and to strengthen the construct validity of the case study.^{47 52 53} The authors’ reflexivity statement has been added as an online supplemental appendix.

RESULTS

Findings from the mixed methods systematic review

Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 diagram

As depicted in figure 3, the initial literature search identified 1520 records, of which 1473 were from peer-reviewed literature and 47 from grey literature. After removing duplicates from the 1473 peer-reviewed records, we screened the titles and abstracts of the remaining 871 records, of which we excluded 707 irrelevant records, and sought 164 reports for retrieval. Then we assessed the retrieved full texts of 160 reports for eligibility, of which we excluded 70 irrelevant reports and 35 other reports that did not mention Guinea and included 55 reports in the synthesis. An irrelevant report was any report whose content (results and conclusion) did not present any lesson learnt related to outbreak response. As for the grey literature, from the 47 reports identified, 30 were sought for retrieval after screening the titles, of which five were discarded for not being relevant. A full-text assessment of the remaining 25 reports was done, and 15 were found relevant and included in the synthesis. Overall, 70 reports were included in the synthesis.

Box 2 Mixed methods systematic review

We selected the mixed methods systematic review as the most appropriate review method to address the review question.¹¹⁹ A mixed methods systematic review provides a more complete basis for complex decision-making than that offered by a single method review, thereby maximising its usefulness to clinical and policy decision-makers.¹¹⁹ The review included peer-reviewed and grey literature on outbreaks in Guinea over the study period. Both quantitative and qualitative research designs and mixed methods primary research were included in the review.¹¹⁹ In this review, we used the term 'report' instead of 'study', as it encompasses various documents (paper-based or electronic) that are relevant to the review question.¹²⁰

Review question

The review applied the setting-perspective/population-intervention/phenomenon of interest-comparison-evaluation (SPICE) question formulation framework¹²¹ (online supplemental file 1). The review question was formulated as follows: *How has Guinea's health system learnt from the response to outbreaks over the past 8 years (2014–2021)?*

Search strategy

A systematic electronic search was performed through PubMed, Web of Science and Google Scholar databases. The search filters included all study types (all fields), reports on Guinea outbreaks between January 2014 and December 2021, free full texts and French and English languages. Search terms or keywords were used for a pilot literature search, and when appropriate, Boolean operators helped combine them and develop a search strategy (online supplemental file 2). Medical subject headings were applied to synchronise synonymous terms in PubMed. In addition, Google customised search was carried out for online books, policy and professional websites, webpages, reports and outbreak response plans. The last search was performed on 5 March 2022.

Selection and appraisal of reports and data extraction

All records identified from databases, websites and webpages were saved in Mendeley software then imported into Rayyan software¹²² for screening (removing duplicates). The selection of reports for review followed the updated Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 statement.¹²⁰ The appraisal of reports relied on the relevance of the information they contained related to lessons/recommendations about the response to outbreaks over the study period in Guinea, which determined the reports' inclusion in the synthesis. The included reports consisted of research articles (both observational and interventional studies, eg, field intervention), reviews, letters to editors, policy briefs, case reports, perspectives, debates, opinions, commentaries, books, websites, webpages, organisational reports and outbreak response plans. The reports for which the full text could not be retrieved were excluded. Reports' selection and appraisal were made independently by two researchers (TMM and BSC). Data were extracted using a 2016 Microsoft Excel spreadsheet. The following report characteristics were extracted: corresponding author, publication year, country, type of report, study design, outbreak, main lessons learnt or recommendations.

Data synthesis and analysis

We used a convergent integrated approach for evidence synthesis and integration.¹¹⁹ Narrative and tabular data synthesis were performed, followed by a chronological and thematic analysis.¹²³ Data were triangulated across sources in the narrative synthesis, while the tabular synthesis depicted the characteristics of reports and a short description of the lessons/recommendations. In the analysis, data were organised following the occurrence chronology of outbreaks they relate to, and themes (learning aspects) from the conceptual framework were applied when appropriate.

Synthesis of lessons and related learning dimensions or aspects

The characteristics of reports included in the synthesis and lessons learnt or recommendations for rapid control of future outbreaks are displayed in online supplemental file 3. Here, we summarised these lessons following the chronology of outbreak occurrence, described whether lessons from the previous outbreaks (eg, 2014–2016 EVD) were incorporated in responding to future outbreaks and pointed out the dimensions or aspects across which learning occurred.

Ebola virus disease (2014–2016)

The 2014–2016 EVD outbreak spread over 30 out of 38 health districts and lasted about 2 years and half, with 3814 infected cases (3358 confirmed cases and 456 probable cases) and 2544 deaths (a total case fatality rate of 67%).⁴² The main lessons learnt from the response to outbreaks over the study period came from EVD and they are grouped according to the health system building blocks (table 1).

This learning occurred through information (research and experts' opinions), action and practice (learning by doing) and deliberation/double-loop learning (decisions to withdraw the military from the response, involve anthropologists and create the ANSS—the change in the governing norms). Most lessons learnt were incorporated by the health system during and/or after the outbreak, through deliberation, single-loop, double-loop and triple-loop learning, as illustrated in table 2.

Measles

Since 2017, the Measles outbreak has been challenging the health system. The transmission persistence is due to insufficient herd immunity levels, which requires further reproduction number estimation to help decision-makers and field staff understand outbreak progress and the timing and type of vaccination efforts needed to stop transmission.⁵⁵ This learning was produced through information (research). However, we have not found

Box 3 The online survey

An online survey was preferred to reach wider audience and because of time and resource constraints.^{124 125} The survey was qualitative and conducted using an electronic (KoBoToolbox¹²⁶) semi-structured questionnaire, whose design was informed by the conceptual framework. The questionnaire was pretested with non-participants to check the clarity of the questions and reformulate those that posed problems of understanding.

Participant sampling and recruitment

The survey targeted key informants at all levels of Guinea's health system and from partner organisations. They were purposively selected and consisted of community actors (members of the Committee for Health and Hygiene - COSAH), district medical officers (DMOs) and regional health inspectors (RHIs) in health districts and regions where at least one outbreak has been experienced within the study period, one representative from the ANSS, and one representative from each technical and financial partner such as WHO, CDC, UNICEF, IOM, UNFPA, USAID, Amref Health Africa, CRS, Red-Cross and Jhpiego. They were approached via email addresses. Since all the DMOs and RHIs and some staff from the central level participated in the 'District.Team' initiative, their electronic mailing list was still available.⁹⁴ The email addresses of key informants from partner institutions and newly appointed DMOs and RHIs were obtained from the Ministry of Health. The community actors received the questionnaire through the DMOs, who distributed it to the heads of the health centres (themselves members of the COSAH), who shared it with the whole COSAH.

Data analysis

Data from KoBoToolbox were exported to a 2016 Excel spreadsheet and downloaded. The overall case study database was developed to ensure the reliability of this case study.^{47 52 53}

Thematic and content analysis was carried out manually by the primary author (TMM). Data were triangulated across respondents (eg, enablers, barriers and recommendations), contributing to ensuring the credibility or internal validity of the case study.^{47 52 53 127} The information was then analysed using deductive coding (based on the conceptual framework and contextual factors). The codes were classified into main categories (levels, loops, means and contextual factors) and subcategories (individual, team, organisation, cross-organisation (for levels); single, double and triple (for loops); information, deliberation and action (for means); enablers and barriers (for contextual factors).

Monitoring and quality control

The first author (TMM) assured data monitoring and quality control daily. KoboToolbox offered the possibility to verify the completeness/accuracy of data submitted by respondents. The respondents who submitted incomplete questionnaires were requested via email to complete the missing information when needed.

evidence in the literature on whether the health system has incorporated this learning or not.

Lassa fever

Lassa fever, which was first diagnosed in October 2011 in Guinea, is now endemic in the country. One reason could be the challenge in early identification of the disease in remote areas, that is, at health centre level.⁵⁶ Thus, there is a need for regular awareness training to facilitate the implementation of improved field surveillance and early detection.⁵⁶ The chemical treatment effectively controls local rodent populations. It can partly serve as a practical, holistic approach combining rodent trapping, use of local rodenticides, environmental hygiene, house repairs and rodent-proof storage.⁵⁷ Eradicating the Lassa virus requires controlling rodents in neighbouring villages, and the risk of Lassa virus spillover is heterogeneously distributed within Guinea's villages.⁵⁸ This learning happened through information (research) and was probably taken into account by the health system, as the ANSS strengthened multisectoral actors' capacity in the 'One Health' approach (through deliberation and double-loop learning), which has been implemented in the country since 2019 for better control of zoonotic diseases.⁵⁹ However, we have not found evidence about triple-loop learning.

COVID-19

The primary outbreak that followed EVD was COVID-19, declared on 12 March 2020, the response of which

recorded improvements and success drawn on lessons learnt from the response to the EVD outbreak, such as—the early diagnosis of the disease (the first case detected within 48 hours) due to strengthened disease surveillance, outbreak investigation and laboratory capacities—the availability of epidemic treatment and isolation centres—and the knowledge about how to elaborate an outbreak response plan. In fact, the response plan was elaborated (in February 2020) even before the onset of the outbreak in the country.⁶⁰ This plan included most of the lessons from the response to EVD outbreak in terms of epidemiological surveillance, laboratory, infection prevention and control, information and communication, logistics, coordination, community engagement, risk communication, treatment centres, data collection and contact tracing (Go.Data) and also included a component specific to clinical manifestation of COVID-19, such as resuscitation. For instance, a community response strategic plan called 'stop COVID-19 within 60 days'⁶¹ was implemented referring to the 'zero Ebola within 60 days' strategic plan successfully carried out during the EVD outbreak.⁶²

However, despite the introduction of rapid readiness and response measures, some health system weaknesses persist (eg, lack of financial resources), and the unique nature of COVID-19 continues to challenge control efforts.⁶³ From these weaknesses, lessons that could be incorporated to improve future outbreak responses were connected to strengthening contact tracing, early community engagement,⁶⁴ optimal outbreak

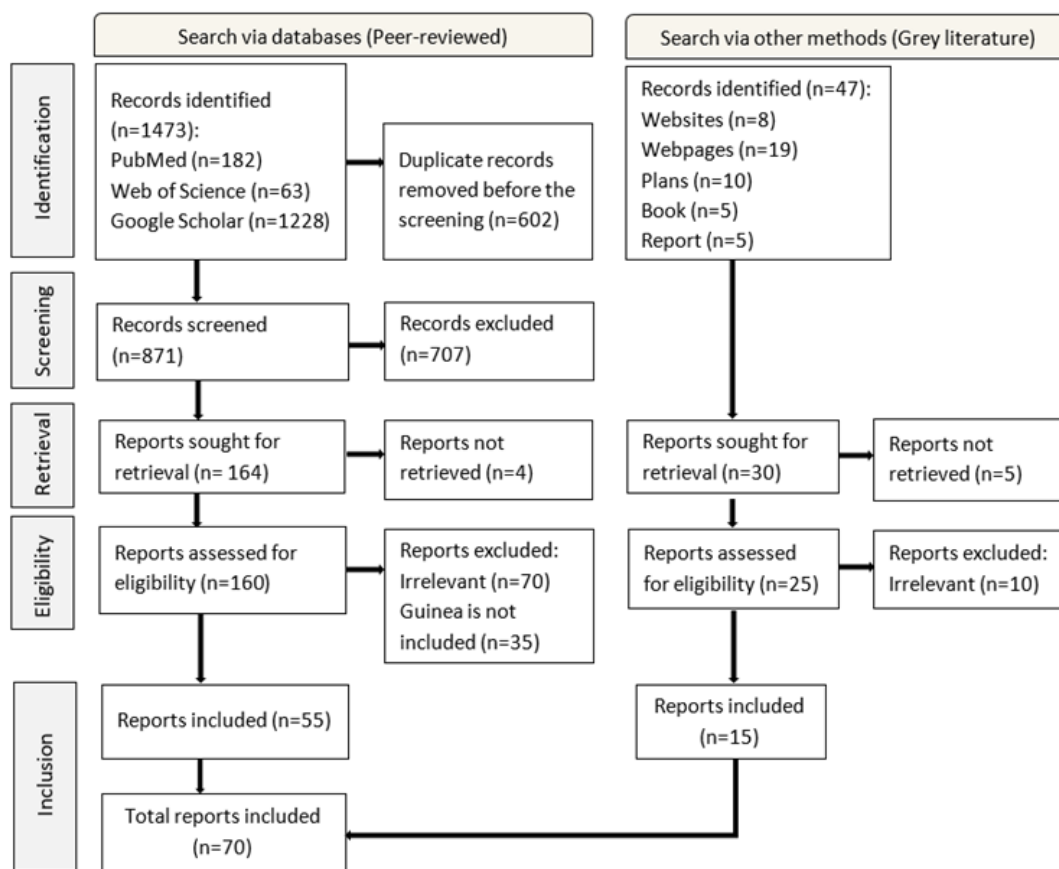


Figure 3 PRISMA 2020 updated flow diagram.¹²⁰ PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

preparedness (eg, sufficient case detection and response capabilities)^{65 66} and reflecting on strategies to mitigate the effects of political unrest on outbreak control efforts or implementation of the response plan.^{64 67} Moreover, for more success in responding to outbreaks, the health system needs to rethink the governance of the outbreak response by prioritising internal resource mobilisation and creating better synergy between national institutions to pool existing strengths and gain support from communities. To this end, national institutions tasked with each response pillar should be identified and provided with the required resources (eg, local budget lines) under the coordination of the MoH or the designated institution. When doing so, the path for long-term capacity building of local actors with support from technical and financial partners could be established.^{66 68}

Besides, the COVID-19 pandemic jeopardised efforts to achieve Sustainable Development Goals for maternal and child health in urban settings in Guinea. Therefore, for the country's health system to be more resilient to crises such as COVID-19, interventions are needed to ensure the continuity of maternal and neonatal care.⁶⁹

These lessons were learnt through information (research and experts' views), deliberation (meetings), action and practice ('stop COVID-19 within 60 days' strategy) and single loop (elaboration of the response plan). Looking at the above lessons to be considered to

improve future outbreak response, it appears that many lessons learnt from the response to the EVD outbreak were not adequately incorporated by the health system. Therefore, learning through action and practice was limited beyond the missing double-loop and triple-loop learning.

Ebola virus disease (2021)

Amid COVID-19, the MoH declared the EVD outbreak in the health district of N'zérékoré on 14 February 2021. Three confirmed and four probable cases and five deaths (one confirmed+the four probable) were notified two days later. The outbreak was successfully controlled within one health district and within four months, with 23 infected cases (16 confirmed+seven probable cases), of which 12 deaths (a total case fatality rate of 52%) and 11 cured/survivors. This success pertains to the integration into the response plan of experience and most lessons learnt from the 2014–2016 EVD outbreak.⁷⁰ These success factors include strengthened epidemiological surveillance, the deployment of skilled Guinean professionals trained during the previous EVD at all response pillars, good coordination and synergy of partners' actions, early community engagement and ring vaccination.⁷¹ Moreover, a '90 days strengthened surveillance plan' was designed and implemented with the aims of—maintaining and

Table 1 Lessons learnt from the 2014–2016 EVD response, Guinea

Health system building blocks	Lessons learnt
Leadership and governance	<ul style="list-style-type: none"> ▶ Engaging community early in the response^{43 57 77 85 128–136} ▶ Performing social mobilisation^{43 77 85 128 133 135 137} ▶ Strengthening community participation^{138 139} ▶ Ensuring multisectoral collaboration^{139 140} ▶ Establishing a sustainable structure (ANSS) for outbreak response with an autonomous management mandate⁸⁵ ▶ Elaborating the national post-Ebola health system strengthening investment plan¹⁴¹ ▶ Enhancing governance⁸⁵ ▶ Evading the deployment of armies, especially western armies on the ground, to avoid fear in communities and prevent mistrust and violent fatal attacks on healthcare workers (HCWs) and volunteers¹³³ ▶ Avoiding partners or ‘friends’ command according to what they have known or used elsewhere, and taking into account local skills in the command⁸⁵
Human resources	<ul style="list-style-type: none"> ▶ Prioritising investment in health personnel (training and capacity building, increasing the number through recruitment and retention strategies)^{85 132 137 142–145} ▶ Involving social scientists/anthropologists early in the response^{45 146–149} ▶ Putting local professionals to the fore of the response while external agents being in the background¹⁵⁰
Service delivery	<ul style="list-style-type: none"> ▶ Enhancing preparedness to mitigate outbreak-collateral effects by designing parallel strategies and interventions to counter service disruptions (tuberculosis, maternal and child health including nutrition and prevention of mother-to-child transmission of HIV, malaria in under-five) particularly, developing toolkits for monitoring health service disruptions and adjusting programmes accordingly^{129 151–156} ▶ Preserving communities’ values and addressing outbreak-related psychological effects^{157 158} ▶ Implementing ring vaccination¹⁵⁹ ▶ Ensuring long-term follow-up of EVD survivors, as the virus can persist in their seminal fluid for a long period of time (531 days after onset of disease)¹⁶⁰ ▶ Strengthening infection prevention and control (IPC)¹⁶¹ ▶ Addressing underlying social determinants of the country’s vulnerability and weak capacity for a successful response to outbreaks¹³² ▶ Addressing survivors’ emotional reactions¹⁵⁸
Information and knowledge	<ul style="list-style-type: none"> ▶ Combining epidemiological surveillance with molecular surveillance (real-time sequencing)^{148 150 160 162} ▶ Conducting crisis communication^{85 131 163} ▶ Improving disease surveillance, including setting up the surveillance and alert system for early detection of EVD resurgence among survivors, and expanding disease-specific surveillance to areas surrounding the outbreak’s known geography^{145 164–166} ▶ Building a multifaceted motivational approach which emphasises motivational messages that refer to patriotic values and moral responsibility when recruiting volunteers¹⁶⁷
Infrastructure and supplies	<ul style="list-style-type: none"> ▶ Developing health infrastructure and equipment (epidemic treatment centres and laboratory capacity building)^{85 144 145} ▶ Conducting a real needs assessment to avoid purchasing useless equipment⁸⁵
Finances	Managing the mobilised funds with transparency ⁸⁵

ANSS, National Agency for Health Security; EVD, Ebola Virus Disease.

strengthening community-based surveillance through the ‘One Health’ platforms—ensuring vaccination of health staff, corpse washers, traditional healers, red-cross staff, survivors’ relatives in the region of N’zérékoré—and strengthening the survivors’ monitoring programme, that is, clinical, biological and psychological monitoring, surveillance and vaccination around survivors and research.⁷² However, as the Ebola virus can persist in survivors’ body fluids for five years, research efforts must focus on potent antiviral agents

that can eradicate the latent virus reservoir in patients with EVD and on efficient vaccines that provide long-term protection.⁷³

Here, learning occurred through information (research, eg, survivors’ clinical, biological and psychological monitoring), deliberation (meetings), action and practice (ring vaccination, community engagement) and single loop (development of the response plan). However, no evidence exists about double-loop and triple-loop learning.



Table 2 Incorporation of lessons learnt from the 2014–2016 EVD outbreak, Guinea

Learning aspects	Examples of incorporation ways of lessons	After the outbreak
Deliberation	Meetings and stakeholder consultations, for example, MoH, policy entrepreneurs and partners/donors	NA
Single-loop learning	Reconstitution of regional and district epidemic alert and response teams. ⁸⁵ — <i>It corresponds to adjustments and corrections in the system to achieve the outbreak response goals without questioning the underlying causes of problems.</i>	NA
Double-loop learning	<p><i>Example 1:</i> Creation of the Ebola national coordination unit on 5 June 2014 which managed the EVD response up to its end in 2016 under the leadership of the president of the republic, in replacement of the national committee for health crisis (which existed before the EVD and was activated on 23 February 2014) because of its unsatisfactory management of the outbreak response over 4 months.</p> <p><i>Example 2:</i> Questioning the underlying causes of the dysfunction and poor performance of the health system, which led to the rapid spread of the EVD within and outside the country, through a popular forum ‘the general states of health’ organised by the MoH and its partners in May 2015 (during the outbreak).¹⁶⁸ The forum noted that the health system was characterised by—a still high morbidity and mortality rate, particularly among mothers and children—an insufficient coverage of essential health services, the quality of which was sometimes questionable—an inefficient and inequitable healthcare provision within an inappropriate environment and a lack of access to health services.¹⁶⁸</p> <p>Then, developing the 2015–2017 health system recovery and resilience plan (part of the 2015–2024 national health development plan) to address the issues highlighted at the forum and the lessons learnt from the EVD response.¹⁴⁹ Therefore, the expected and/or achieved changes included:</p> <ul style="list-style-type: none"> ▲ EVD (and other diseases) eliminated through strengthened infection prevention and control, improved integrated disease surveillance and response and international health regulations¹⁶⁸ ▲ Improved performance of the local health system through improved service delivery and strengthened management system¹⁶⁸ ▲ Enhanced health system governance through support to management, coordination, accountability, community engagement and regulation¹⁶⁸ ▲ Reformed health sector by prioritising investment in health personnel (2950 health professionals recruited and deployed, some of whom received training/capacity building)^{44, 169–171} ▲ Built health infrastructures (38 epidemic treatment centres and laboratory capacity were built).^{85, 172} 	NA
	<p><i>Example 3:</i> Moreover, after the EVD an epidemic preparedness plan was elaborated for a 5 year period.⁸⁵ As part of this plan, the Ebola national coordination unit was dissolved and replaced with the ANSS which is a sustainable structure with an autonomous management mandate, now responsible for organising epidemiological surveillance and response and preparing the country’s health security capacity-building.⁸⁵</p>	<p>NA</p> <p>▲ <i>These examples relate to questioning the health system’s fundamental framework and assumptions around problems and their solutions resulting in changes at the level of governing norms, policies and objectives/goals</i></p>

Continued

Table 2 Continued	
Examples of incorporation ways of lessons	
Learning aspects	After the outbreak
Triple-loop learning	<p>The health system, capitalising on learning from the EVD outbreak response, engaged in learning how to improve the disease surveillance process. It set up a new disease surveillance system using DHIS2 over 4 years, from the pilot in two health regions between Mai and November 2017 to scale up at the national level between January 2018 and March 2020.⁸⁷ This new process which resulted from substantial evolution (from a system focused on aggregate reporting only, transmitted from health facilities to the national level by phone and case forms on paper, to a fully integrated and electronic disease surveillance system that allows both for aggregate and individual case reports proved instrumental in COVID-19 response for which a module for case data was swiftly established in the DHIS2 by the ANSS in March 2020.⁸⁷ Using DHIS2 for the COVID-19 response, stakeholders, including laboratories, now better understand and support the process of individual case reporting and timely data entry, as they can see the line lists with case characteristics, yield summary statistics, and have a real-time dashboard useful to evidence-based decision-making.⁸⁷</p> <p>▶ <i>This corresponds to improvements in how the health system learns through deliberate changes in learning structures, processes and strategies.</i></p>
ANSS, National Agency for Health Security; DHIS2, District Health Information System version 2; EVD, Ebola Virus Disease; MoH, Ministry of Health; NA, not applicable.	

Marburg virus disease

On 3 August 2021, two months after, the end of the EVD outbreak, while COVID-19 was in progress, the health district of Guéckédou was alerted by the health centre of Koundou, located 54 kilometres from Guéckédou city, of a community death of a 46-year-old male resident of Tèmèsadou M'boket (a small village situated nine kilometres from the Sierra Leone border). An investigation team was immediately deployed to the village and conducted a preliminary investigation by collecting a postmortem oral swab sent to the viral haemorrhagic fever laboratory in Guéckédou the same day. The result of the reverse transcription-PCR test on 3 August 2021 was positive for Marburg virus disease. Immediately, a multidisciplinary team was put in place to implement response activities supported by a response plan.⁷⁴ The outbreak was controlled within 42 days, with only one confirmed case/death. The rapid implementation of response activities, coupled with the experience of the affected health district in fighting against viral haemorrhagic diseases, played a central role in controlling the epidemic's spread to other health districts and the neighbouring countries.⁷⁵ In particular, the training and vigilance of HCWs in the surveillance of epidemic-prone diseases were essential to the early detection of the case.

“We immediately informed the district health authorities so that they could take a sample,” as asserted the lead of the health centre of Koundou.⁷⁶

In addition, effective contact tracing, community engagement, social mobilisation, improvement in border disease surveillance and WHO experts' support for outbreak investigation, rapid emergency response and improvement in disease surveillance and testing were instrumental in the rapid outbreak control.⁷⁷ The WHO Regional Director for Africa, impressed with the growing expertise in outbreak response in Guinea, stated:

Without immediate and decisive action, highly infectious diseases like Marburg can easily get out of hand. Today we can point to the growing expertise in outbreak response in Guinea and the region that has saved lives, contained and averted a spillover of the Marburg virus.⁷⁸

However, the source of the epidemic is still unknown, and the wife of the unique case could not be found, which constitutes a significant risk for the resurgence of cases. Consequently, investigations and research (seroprevalence of Marburg in the population of Guéckédou) were in progress during the review period.⁷⁵

Here, learning happened through information (notification of death, oral swab collection and testing), deliberation (meeting and expert consultations), action and practice (implementation of outbreak response activities, eg, surveillance, contact tracing and community engagement), single loop (elaboration of the response plan and on-site testing thanks to laboratory capacity building). Besides, ongoing research on Marburg seroprevalence is also a source of learning through

Table 3 Enablers and barriers to learning health system in terms of response to outbreaks in Guinea, 2022

Factors	Enablers	Barriers
Organisational structure	<ul style="list-style-type: none"> ▶ Creation of the national agency for health security (ANSS)* ▶ Decentralisation of coordination teams (ERARE, EPARE/ECARE)* ▶ Activation of COU-SP ▶ Existence of research and training facilities ▶ Existence of a scientific advisory committee 	<ul style="list-style-type: none"> ▶ Lack of ownership of the concept of LHS† ▶ Over-dependence on technical and financial partners
Learning-friendly leadership and hierarchical culture	<ul style="list-style-type: none"> ▶ Availability of political and administrative authority 	<ul style="list-style-type: none"> ▶ Cultural, hierarchical and political considerations† ▶ Suboptimal enabling conditions ▶ Ignorance of the bottom-up planning/voice in decision-making† ▶ Lack of staff accountability
Human resources	<ul style="list-style-type: none"> ▶ Availability of human resources (including the presence of experts) ▶ Presence and commitment of staff, in particular, those who participated in the EVD outbreak response* ▶ Trained staff in FETP 	<ul style="list-style-type: none"> ▶ Lack of time in DHMTs ▶ Interference of activities (multiplicity of vertical programmes) in health districts ▶ Lack of commitment of DHMTs (reluctance in some cases) ▶ Lack of ownership of the concept of LHS†
Financial, logistic and technical resources	<ul style="list-style-type: none"> ▶ Support from development partners 	<ul style="list-style-type: none"> ▶ Lack of funding (non-implementation of the decisions made at the bottom level)† ▶ Lack of logistic resources ▶ Technical barriers (internet, computer equipment)
Active learning agenda and vision	NA	<ul style="list-style-type: none"> ▶ Insufficient establishment of objective or performance contracts to stimulate learning
Capacity building	<ul style="list-style-type: none"> ▶ Continuous training/capacity-building workshops ▶ Experience/solution sharing (lessons learnt and good practice)* 	NA
Enabling environment for teamwork	<ul style="list-style-type: none"> ▶ Motivation of staff by the hierarchy ▶ Involvement of all stakeholders, including partners, communities and socio-anthropologists 	<ul style="list-style-type: none"> ▶ Insufficient communication between the community and the health staff (lack of information and awareness)†
Non-alignment of incentive structures to learning requirements	NA	<ul style="list-style-type: none"> ▶ Lack of reward/sanction system ▶ Delay in paying workers ▶ Incentives related to the distance for workers in remote areas not taken into consideration
Monitoring and evaluation	<ul style="list-style-type: none"> ▶ After-action review 	NA
Outbreak	<ul style="list-style-type: none"> ▶ Presence of the outbreak itself 	<ul style="list-style-type: none"> ▶ Politicisation of outbreaks ▶ Rumours

*Commonly-reported enablers.
 †Commonly-reported barriers.
 COU-SP, Public Health Emergency Operation Centre; DHMTs, District Health Management Teams; ECARE, Communal Epidemic Alert and Response Team; EPARE, Prefectural Epidemic Alert and Response Team; ERARE, Regional Epidemic Alert and Response Team; EVD, Ebola Virus Disease; FETP, Field Epidemiology Training Programme; LHS, Learning Health System.

information. However, we have not found in the reports we reviewed evidence of what we could categorise as double-loop and triple-loop learning.

Findings from the survey

In this section, we showed participants' characteristics, described learning that occurred at the different health system levels employing the learning dimensions, determined enablers and barriers to LHS from

the respondents' perspective and formulated recommendations for improvement of learning within the health system from the perspective of respondents.

Participants' characteristics

Overall, 33 key informants participated in the survey, including one representative of the ANSS (central level), five regional health directors (regional level), 13 district medical officers (DMO) (district level), five community

Table 4 Recommendations for learning improvement linked to outbreak response in Guinea from respondents' perspective, 2022

Recommendation	Related factor (result)	Recommendation target	Implementation term
<ul style="list-style-type: none"> ▶ To improve the leadership of the MoH and coordination ▶ To improve the governance and management system at all levels, including transparency and accountability to the population, government and donors* ▶ To create a sharing environment and making available the necessary resources 	<ul style="list-style-type: none"> ▶ Learning-friendly leadership and culture 	<ul style="list-style-type: none"> ▶ MoH General Secretariat ▶ MoH Policy advisor 	<ul style="list-style-type: none"> ▶ Short (<1 year)
<ul style="list-style-type: none"> ▶ To establish a knowledge management unit within the MoH with representatives at regional and district levels* ▶ To strengthen operational research at the health district level ▶ To improve the use of the digital strategy for facilitating learning* ▶ To involve all stakeholders on all health issues ▶ To institutionalise key learning functions within the Guinean health system* 	<ul style="list-style-type: none"> ▶ Organisational structure 	<ul style="list-style-type: none"> ▶ MoH General Secretariat ▶ Office for strategy and development 	<ul style="list-style-type: none"> ▶ Short to medium (1–3 years)
<ul style="list-style-type: none"> ▶ To create and deploy human capacities required to perform learning functions* ▶ To promote local recruitment based on priorities 	<ul style="list-style-type: none"> ▶ Human resources 	<ul style="list-style-type: none"> ▶ MoH Training Service ▶ Programme coordinators ▶ ANSS director ▶ RHIs/DMOs 	<ul style="list-style-type: none"> ▶ Short/medium
<ul style="list-style-type: none"> ▶ To create performance or target contracts with managers at the ANSS, regional and district levels 	<ul style="list-style-type: none"> ▶ Active learning agenda and vision 	<ul style="list-style-type: none"> ▶ Managers' hierarchical supervisors ▶ Partners 	<ul style="list-style-type: none"> ▶ Medium
<ul style="list-style-type: none"> ▶ To provide the necessary resources for the implementation of activities* ▶ To improve the financial contribution of the government to be less dependent on TFPs ▶ To continue supporting health structures with logistics, communication and funding ▶ To ensure technical and financial support to COSAH, reinforcing community health and real-time information sharing 	<ul style="list-style-type: none"> ▶ Financial, logistic and technical resources 	<ul style="list-style-type: none"> ▶ MoH General Secretariat ▶ MoH Policy advisor ▶ Partners 	<ul style="list-style-type: none"> ▶ Short to medium

*Commonly-reported recommendations.
 ANSS, National Agency for Health Security; COSAH, Committee for Health and Hygiene; DMOs, District Medical Officers; MoH, Ministry of Health; RHIs, Regional Health Inspectors; TFP, Technical and Financial Partner.

actors and nine representatives of different partners (online supplemental file 4).

Learning at the central, regional and district levels

The ANSS informants responded to all outbreaks in Guinea from 2014 to 2021. Each health district experienced at least one outbreak that the regional health inspectors and DMO were involved in controlling. In summary, the ANSS staff, the RHIs and DMOs have mostly learnt through fundamental aspects (information, deliberation and single loop) and partly across action and double loop, while triple-loop learning was missing.

Online supplemental file 5 details learning that occurred at the central, regional and district levels.

Learning at the community level

Over the study period, the first outbreaks that community respondents were involved in fighting against were the EVD outbreak (2014–2016) and Polio (cVDPV2 – October 2021). Most community respondents were involved in EVD outbreak response, and one was involved in Polio control. Respondents are all man and from four health districts, namely, Guéckédou, Kissidougou, Dabola and Faranah.

Box 4 Our observations about the learning health system (LHS) analysis framework

This framework enlightens the concept of learning health system by encompassing good features of learning organisation from the literature. Certain frameworks used in health systems, such as Cynefin's, allow for learning but are limited in their current conceptualisation and application. The Cynefin framework,^{173 174} a leaders' decision-making tool, brings about action-focused learning, from which the other learning aspects (except triple-loop learning) can derive according to the different levels of uncertainty (simple, complicated, complex and chaotic). As an illustration, Holly *et al*¹⁷⁵ applied the Cynefin framework to report on a learning approach to community response during the COVID-19 pandemic in the USA, which missed the triple-loop learning.

Despite the value of the current LHS analysis framework, we operationally and conceptually noticed that some areas need to be improved. First, double-loop and triple-loop learning boundaries are blurred in practice and can be inversely and confusingly employed. Confusion may arise from the diverse conceptualisations of triple-loop learning in the literature, some of which overlap with double-loop learning. Nevertheless, to operationally distinguish between learning loops, we think that it may be helpful to pay attention to key attributes (expected changes) such as—altered actions (for single-loop learning)—altered governing norms, policies or objectives/goals (for double-loop learning)—altered learning processes, structures or strategies (for triple-loop learning). Second, the emotional aspect of learning (learning by feeling/going through) is not captured by the current LHS analysis framework. This could be taken into account by reframing learning through action/practice (learning by doing/seeing) as 'learning through experience' because the latter incorporates the former and learning by feeling things.¹⁷⁶ We believe that as individuals, teams and even organisations, we also learn by 'going through'. For instance, experiencing barriers, facing humiliation, hate, discrimination, fighting bureaucracy, political oppositions or private interests call to deeper human processes than adapting routines or solving problems. Also, learning coming from handling an epidemic can entail strong emotions (pain, death, fear, stigmatisation) that are source of learning (willingness to change) for a team, society or nation, though these emotions can be sometimes tough. Thus, the description of 'learning through experience' could be extended to knowledge translation to explain how knowledge generated by doing, seeing or feeling can be applied.⁸³ Third, the current framework focuses only on analysing the learning process. It does not say anything about learning outcomes. However, analysing an LHS must consider both the learning process and outcomes for a comprehensive performance evaluation. Therefore, there is a need to review the current framework design by relating the learning dimensions to outcomes (key changes/potential benefits) with a description about how to evaluate outcomes. For instance, when the framework is applied to a specific domain (eg, outbreak response or maternal deaths surveillance and response system), the evaluation of learning outcomes (health system performance) may draw on the domain-specific indicators. Last, further studies are needed to widely deploy the LHS framework in different contexts to help scholars and practitioners better understand its practicalities and facilitate analysing LHS.

In short, to operationally and conceptually improve the current framework, we suggest—making a clear distinction between learning loops—reframing learning through action/practice as 'learning through experience'—relating the learning dimensions to outcomes with a description about how to evaluate outcomes—and deploying the framework in different contexts.

They were tasked with awareness-raising on outbreak preventive measures, kit distribution, social mobilisation and management of community reluctance.

After training on the disease [Ebola], we were hired to raise awareness in the community and on the radio (community relay, man).

I was part of one of the committees set up to deal with reluctance and community mobilisation to adhere to the outbreak control measures (community leader, man).

My role was to distribute hand-washing kits and inform people to report foreigners who come for visits or to the market, and I was involved in transporting corpses from point A to point B (community relay, man).

More than half of them fought against the outbreak (COVID-19) that followed the one they were involved in responding to for the first time. The non-involvement of certain informants in future outbreak response was due to either the non-availability (hired on another activity) of the person concerned or because his/her health area/locality did not experience any future outbreak.

Respondents reported having learnt lessons from the health system outbreak control strategies such as the involvement of all actors (including communities) in the response, setting up committees in the villages to task with alerts, recommendations to comply with hygiene rules, wearing of face masks, physical distancing, hand

Box 5 Study implications

We hope that the findings of this study will inform policymakers and decision-makers about strategies or mechanisms required to build an learning health system (LHS) or advance learning within Guinea's health system, particularly by relying on recommendations made. Furthermore, this study could stimulate the emergence of a learning ecosystem in Guinea, as the current study and our past work on learning^{38 46 169–171} show that there is a promising momentum. This hope is supported by the increase in the number of Guinean first authors on scientific papers (eg, 21/55 peer-reviewed papers included in the evidence synthesis have a Guinean as first author). Moreover, as Guinea's health system tackles multiple public health challenges in succession/parallel, the evidence of lessons learned and incorporated would help it raise its profile in the African region and could support the mobilisation of technical and financial resources needed to institutionalise key learning functions. Finally, demonstrating that Guinea's health system actively incorporates what it learns into its approaches and actions might encourage other African countries' MoH to set their own goals of establishing their countries' health systems as LHS and to strengthen domestic research capacity, especially for health policy and systems research.

Table 5 Recommendations from researchers related to learning improvement within Guinea's health system

Recommendations	Recommendation target	Support	Implementation term
▶ To take into account the recommendations made by respondents (cf. table 4) because they contribute to building an LHS. We suggest starting with a cluster or consultation meeting to discuss these recommendations and prioritise and advocate them.	▶ MoH General Secretariat ▶ ANSS Director ▶ Programme coordinators ▶ RHIs ▶ DMOs	▶ Partners ▶ Experts	▶ Short ▶ (<1 year) to medium (1–3 years)
▶ To establish regular post-action reviews	▶ ANSS Director ▶ RHIs ▶ DMOs	▶ Partners	▶ Short
▶ To balance investments in the health system hardware and learning capacities	▶ MoH General Secretariat ▶ MoH Policy Advisor ▶ Partners	▶ Partners	▶ Short/medium
▶ To train/build the capacity of staff at the ANSS, regional, district and community levels in knowledge management and the concept of LHS	▶ MoH Secretariat General ▶ MoH Training Service	▶ Partners ▶ Experts	▶ Short/medium
▶ To strengthen supportive supervision	▶ Programme coordinators ▶ Managers	▶ Partners	▶ Short
▶ To establish and align incentive mechanisms to learning requirements	▶ MoH General Secretariat ▶ ANSS Director ▶ Programme coordinators ▶ RHIs ▶ DMOs	▶ Partners	▶ Short/medium
▶ To integrate learning into existing health programmes	▶ MoH General Secretariat ▶ Programme coordinators	▶ Partners ▶ Experts	▶ Short/medium
▶ To develop an active learning agenda and vision	▶ MoH General Secretariat	▶ Experts	▶ Short/medium
▶ To improve/rethink governance in terms of response to outbreaks	▶ MoH General Secretariat ▶ ANSS Director	▶ Partners	▶ Short
▶ To set up a collaboration frame between researchers and policy/decision-makers to motivate knowledge use and learning	▶ MoH General Secretariat	▶ Partners	▶ Short
▶ To invest in domestic capacity for health system research and policy analysis	▶ MoH General Secretariat	▶ Partners	▶ Medium
▶ To recognise and make use of innovations emerging from day-to-day experience	▶ MoH General Secretariat ▶ MoH Policy Advisor ▶ Programme coordinators	▶ Partners	▶ Short
▶ To listen to and learn from communities served by the health system	▶ MoH Directorate of Community Health ▶ RHIs ▶ DMOs	▶ Partners	▶ Short
▶ To incorporate learning into basic training curricula	▶ Faculty of Health Sciences and Techniques (UGANC)	▶ Partners ▶ Experts	▶ Short/medium

ANSS, National Agency for Health Security; DMOs, District Medical Officers; LHS, Learning Health System; MoH, Ministry of Health; RHI, Regional Health Inspector.

washing for public and health staff, the declaration to the hierarchy of any suspected case. They learnt those lessons through deliberation (meetings) and action/practice (written recommendations or shared guidelines). They applied what they learnt across daily use, disease surveillance, awareness-raising, meetings with health professionals, community relays and village committees.

In our area, we set up a multisectoral committee for local decision making and awareness-raising (head of health centre, man).

We work with communities to whom we constantly remind the compliance with outbreak control measures (head of health centre, man).

Learning at the technical and financial partners' level

MoH's technical and financial partners who participated in this study were WHO, UNICEF, USAID, UNFPA, CRS, Jhpiego and Amref Health Africa. WHO and UNICEF were involved in responding to all outbreaks that occurred over the study period. Others responded to at least two outbreaks, the most common of which were EVD and COVID-19.

Respondents reported having learnt many lessons from the strategies used by the MoH in outbreak response. These lessons relate to:

The creation of a national agency in charge of outbreak prevention and response (ANSS) and decentralised coordination teams (ERARE, EPARE/ECARE, COU-SP).

There was better diligence in the response between the two outbreaks [Ebola 2014 and 2021], such as establishing an agency and coordination bodies and partners' engagement though we faced coordination deficit at times (UNFPA, man).

The focus put on training health staff, equipping health facilities and community engagement.

We learnt from Guinea's MoH that the outbreak response strategy should focus on strengthening the health system by emphasising staff training and equipping health facilities, strengthening community health by focusing training and involvement of affected communities, good coordination of actors and documentation of lessons learnt (Amref Health Africa, man).

The use of past experiences by the MoH in responding to future outbreaks.

Lessons learnt from the 2014–16 EVD outbreak response allowed for rapid control of the 2021 EVD and a better response to COVID-19 (UNICEF, man).

The need for better coordination of mobilised funds for outbreak response, better management of partners' assistance by a strengthened leadership, and ensuring accountability of all actors at all levels.

There was a fairly prompt reaction from the MoH. Efforts were made to mobilise funds. Nevertheless, it should be noted that coordination efforts must be improved to capitalise on the funds received for the response to outbreaks

and strengthen the MoH's leadership for better management of partners' assistance and to avoid everyone doing what they want. Efforts should also be made to improve the responsibility and accountability of MoH officials at all levels (Jhpiego, woman).

They learnt these lessons through deliberation (meetings), action/practice (shared guidelines, written recommendations) and single-loop (participation in elaborating outbreak response plans). Besides, they transmitted to or shared with Guinea's MoH some experiences (organisation/cross-organisation learning) in terms of outbreak response that were mainly about:

Epidemiological surveillance

We shared technical experience in epidemiological surveillance through training on Integrated Disease Surveillance and Response (IDSR) offered to MoH officials, and supervision missions in the field (WHO, man).

Risk communication and community engagement

Based on the response pillars, UNICEF provided expertise in risk communication and community engagement, water sanitation and hygiene (WASH) and infection control and prevention, psycho-social support, child care, community-based surveillance, prevention of sexual abuse and exploitation (UNICEF, man).

Concerning Ebola, we documented the lessons we learnt in the community response approach and shared them with other stakeholders, including the MoH (Amref Health Africa, man).

Infection prevention and control

We have provided infection prevention and control in all aspects, especially in health facilities, to protect providers and clients by ensuring continuity of services. Case management is important but ensuring continuity of services is also essential; thus, the MoH must consider this aspect (Jhpiego, woman).

Minimum initial response package

We shared our experience with the MoH in outbreak preparedness and response through the Minimum Initial Response Package, including capacity building in humanitarian emergency preparedness and response in sexual and reproductive health (UNFPA, man).

Enablers and barriers to LHS in terms of outbreak response in Guinea

Table 3 summarises the respondents' reported enablers and barriers to learning within Guinea's health system from all levels, connected with outbreak response. The commonly mentioned enablers included creating the ANSS and the establishment of its decentralised coordination teams/local governing bodies (ERARE and EPARE/ECARE) and gaining support from development partners. Common barriers included cultural and political considerations and lack of funding resulting in the non-implementation of the decisions made at the bottom level (**table 3**).

Recommendations for learning improvement within the health system (respondents' perspective)

Table 4 depicts the respondents' recommendations to state authorities related to learning improvement within the HS (including in terms of outbreak response). The commonly-reported recommendations included establishing a knowledge management unit within the MoH with representatives at regional and district levels, creating and deploying human capacities needed to perform learning functions and improving the governance and management system at all levels (table 4).

DISCUSSION

This study is the first of its kind to be conducted in Guinea. It analysed how Guinea's health system has learnt from the response to outbreaks. In doing so, it demonstrated how the new LHS analysis framework can be applied. Both systematic review and online survey complemented to answering the research question and improving the construct validity of the case study. The review provided an overview of how the health system has learnt while responding to each outbreak, without specifying learning by HS level. In contrast, the online survey revealed how each health system level has learnt over the study period without focusing on each outbreak.

Our findings reveal that, in the response to outbreaks between 2014 and 2021, the health system learnt to some extent through all aspects of the learning dimensions. The common learning aspects at all the health system levels were learning at the individual, team and organisational levels, through information, deliberation, action/practice, single and double loop. We noted one occurrence of triple-loop learning after the 2014–2016 EVD leading the health system to establish new disease surveillance system. However, triple-loop learning was missing within the ANSS since it started operating and health regions and districts. Besides, learning produced through double loop and action was limited.

Nonetheless, these findings imply that the health system's recent achievements in controlling outbreaks such as COVID-19, the 2021 EVD and the Marburg virus disease could be attributable to fundamental learning aspects (at individual, team and organisation levels, and through information, deliberation and single loop) that happened regularly at all the health system levels and advanced learning aspects (double-loop and triple-loop learning and learning across action) that occurred sometimes and/or partially in the health system. We posit that if the advanced learning aspects (eg, action/praxis, double loops and triple loops) were often and fully implemented at all the health system levels, the health system's functions, adaptivity, innovation and self-reliance would have better improved, leading to more effective and efficient outbreak response. Our results corroborate the existing literature pointing out the challenges in achieving double-loop and triple-loop learning^{79 80} and learning through action.^{81–83}

Below, we separately discussed the outbreak response outcomes and the learning weaknesses of the health system in relation to advanced learning aspects, outlined our observations about the LHS framework (box 4), posited study implications (box 5), acknowledged the study limitations and drew a conclusion.

LHS-wide effects and outbreak response outcomes

Learning truly occurred in the response to outbreaks. This led to improved health system's functions,⁸⁴ increased adaptivity and innovation and greater self-reliance, resulting in better response outcomes, including for haemorrhagic disease outbreaks that followed the 2014–2016 EVD, in terms of outbreak spread, response duration, infected cases and deaths. For instance, the 2014–2016 EVD outbreak spread over 30 out of 38 health districts and lasted about two years and half, with 3811 infected cases and 2543 deaths,⁴² while the subsequent 2021 EVD outbreak was contained within one health district and within four months, with 16 confirmed cases recorded overall, of which five deaths, and the Marburg virus disease was controlled within 42 days, with only one confirmed case/death. These outcomes revealed that the health system's outbreak response performance has improved over time thanks to learning. They exemplified or verified the LHS-wide effects (potential benefits) hypothesised by Sheikh and Abimbola—when means of learning and learning loops happen together either at the individual, team or organisation level, they result in improved performance of the health system's functions, increased adaptivity and innovation and greater self-reliance.²⁰ In terms of performance of the health system's functions, we note—some improvements in the outbreak response governance and leadership (better coordination of outbreak surveillance and response with an autonomous management authority)⁸⁵—the training of health personnel^{85 86}—improvements in service delivery (response and case management)^{85 86}—the building and equipment of health infrastructures (epidemic centres, laboratories and health centres)^{85 86}—the strengthening of health information system using DHIS2 for disease surveillance and reporting^{87 88}—and improvements in finances (increase in the national budget allocated to the MoH, from 3% to 8% in 2018, though this budget remains inferior to the requirement (15%) of the West African Health Organisation), approval of orders for supplies by the laboratory committee and other national committees to reduce waste of resources and improvements in funding mobilisation mechanisms⁸⁵. Regarding the increased adaptivity and innovation, we point out namely—the strengthened capacity of health personnel including the leads of health centres in integrated disease surveillance and response, and computer science—and the developed local genomic surveillance capacity. Concerning the greater self-reliance, we highlight—the primary use of local experts in the response to recent outbreaks (COVID-19, 2021 EVD and Marburg virus disease)—and the established local diagnostic capacity.

Moreover, learning that happened in our context shows the strength of democratic governance and the necessity, though compromised some times, to foster the emergence of institutions that ensure the establishment of rules to enable the discovery of the factual truth.

Double-loop learning

Guinea's health system achieved double-loop learning several times, resulting for instance in the—withdrawal of the military from the EVD response—strong involvement of anthropologists—creation of the ANSS—rise of the one-health paradigm. However, it is noteworthy that double-loop learning is challenging. Argyris said, *It is not easy to create organisations capable of double-loop learning, but it can be done. Even with minimal awareness, the results are encouraging.*⁷⁹ Several reasons explain this challenge—problem solving efforts are more likely to focus on single-loop learning, in which people always try to do the same things right.⁸⁹ However, routines are intended to reduce the necessity for double-loop change, predisposing workers to become desensitised to inner contradictions that routines often develop⁹⁰—The research emphasis on single-loop learning leads to scholarship that is in the service of the status quo. Such limits unnecessarily constrain the progress of inquiry in producing new knowledge⁹¹—Combined, the reasons mentioned above lead researchers and practitioners to create and reward mindsets that inhibit exploring non-trivial changes within organisations, including those originating from their own research and practice.⁹² Institutionalising participatory health governance (democratic governance), which leads to change in policies, practice, behaviour and power relations, is essential to producing double-loop learning.⁹³ As emphasised by the respondents, there is a need to create a real-time information-sharing environment involving all stakeholders on health issues. This will result in improving governance and management systems at all levels, including transparency and accountability to the population, the government and donors. A digital strategy such as the 'District.Team' platform is a showcase that the health system could harness and scale-up to set up such a sharing environment.^{38 46 94} Additionally, among LHS enabling factors that respondents reported, we suggest giving a particular space to regular after-action reviews to yield double-loop learning. An after-action review is a structured review or debriefing process for analysing what happened, why it happened, and how it can be done better by the participants and those responsible for the project or event.⁹⁵ In Nigeria, the establishment of after-action reviews in addition to outbreak surveillance software enhanced the ability of the health system to learn while combatting outbreaks, allowing to shape preparedness for future outbreaks.²⁰

Triple-loop learning

Double-loop learning and triple-loop learning are both 'overhanging' and challenging learning aspects, but of a different order. The former is about the articulation

of explanations of a phenomenon and the latter about the learning process itself. Bateson's conceptualisation of triple-loop learning (learning III) raised a paradox—'learning III (ie, learning about learning II) may lead either to an increase in learning II or to a limitation and perhaps a reduction of that phenomenon'.⁸⁰ Indeed, this led Tosey *et al* to speculate that in many situations, organisations may not be in need of learning or learn through single loop more than transformation (double-loop and triple-loop learning).⁹⁶ In other words, significant improvements in performance can often be achieved through enabling existing competences to be used to greater effect—probably by resisting a felt need for transformation.⁹⁶ Therefore, and as transformation at the triple-loop level in particular, relates to profound changes,^{80 97} Bateson said that triple-loop learning is a rare event.⁸⁰ This Bateson's statement is supported by an empirical study conducted in Tunisia in 2017, which reported that 95% of participating companies (n=60) have not resorted to triple-loop learning in a postcrisis situation related to textile activities, as this learning aspect implies questioning the identity of an organisation, which can lead to the radical transformation of cognitive structures, the way of thinking, methods of working and the way to act, to solve problems and manage all critical situations.⁹⁸ These companies relied solely on single-loop and double-loop learning which was essential to their survival and continuity. Despite the Bateson's paradoxical conceptualisation of triple-loop learning, he stated that certainly triple-loop learning must lead to a greater flexibility in the premises acquired by the process of double-loop learning—a freedom from their bondage.⁸⁰ From this perspective, we assume that triple-loop learning is a beneficial investment to the other learning loops (single and double), which requires deeper strategic thinking. The present work would belong to this category of reflective positioning and raises further questions—Is not systemic learning a central condition for the outbreak response? Can we study this systemic learning in academic institutions? This work will fully reflect triple-loop systemic learning if Guinea's health system translates its findings into policy and practice (eg, creating a knowledge management unit within the MoH with representatives at regional and district levels), leading to the creation of new and well-organised learning structures/processes/strategies. Fahrenbach *et al* suggested that deepening understanding of Bateson's learning III theory is useful to operationalise triple-loop learning.⁹⁹ Furthermore, achieving triple-loop systemic learning requires a very important leadership commitment and momentum for change in depth⁹⁸—leaders can provide a powerful role model of active learning that will help sustain an organisation's efforts, through direct involvement that reflects coordination, vision and integration.¹⁰⁰ In addition, we believe that the institutionalisation of democratic governance mentioned above for double-loop learning is also essential for operationalising triple-loop systemic learning.

Learning through action and practice

Learning through action/practice (learning that emerged from action) was limited at the ANSS and most health regions, while better in health districts. About half of the health regions and districts took advantage of the experiential and tacit knowledge from 'District.Team' to respond to outbreaks. Our findings point out the issue of translating knowledge into action. Ensuring that knowledge produced through repetitive tasks or projects is codified into information and turned into action is complex and challenging.⁸³ Knowledge translation into action is an iterative, dynamic and complex process involving knowledge creation and application (action cycle).^{83 101} The lack of skills in knowledge management is often reported as a common challenge that all decision-makers, that is, clinicians, patients, managers and policy-makers, face.¹⁰¹ Furthermore, several other factors, often local (national or subnational), impact how knowledge is created and used—organisational culture (way things are done)—resources—tools, systems, processes—leadership and governance (influenced by power, politics and policy).¹⁰² Therefore, achieving knowledge translation into action requires an exchange of knowledge among key stakeholders, starting with cultivating appropriate relationships and establishing a shared understanding of what knowledge to action means and why it is crucial.⁸³

Our recommendations for learning improvement within Guinea's health system

In light of the findings and the resulting discussion, our recommendations are formulated in table 5. We particularly emphasise creating a sustainable collaboration frame between researchers and policy/decision-makers to motivate knowledge use and learning.

Study limitations

This study has some limitations. First, the current political context (transitional government originated from a *coup-d'Etat*) in the country might have influenced the participation of some key informants in the online survey, particularly the DMOs. Indeed, some new DMOs have been appointed; their participation might have been affected by the many new duties there are tasked with and the fear of sharing views on such a sensitive topic. Also, they might not have sufficient experience to share as they are new at the job position. Second, since the survey was about past events, this might suffer from recall biases among respondents. Third, we acknowledge that the online survey is not the best data collection method for such research; as a result,—some questions were not well understood and correctly answered by respondents; nevertheless, this limitation was overcome by recontacting those respondents for clarifications;—some answers entailed the need to ask further questions for deeper understanding, but impossible; nonetheless, we resorted to ANSS' experts for clarifications (cf. acknowledgements);—the community voice in the learning discourse was quite limited, as a very few

community actors participated in the survey. All these definitely give an avenue for future research, which need to be conducted in face-to-face and can be people centred (eg, service users) to widely explore their perspective of learning. Overall, combining the survey with the review and the data triangulation across respondents and sources helped to address some limitations (eg, recall biases).

CONCLUSION

Our study highlights the strength of learning, as with the fundamental and partial advanced learning aspects that occurred in the response to outbreaks in Guinea, the health system achieved encouraging outcomes. Therefore, there is a need to advance learning within Guinea's health system, particularly in the response to outbreaks, by turning into action the recommendations issued by both respondents and researchers. Besides, this study provided insights into the LHS analysis framework for informed future application.

Twitter Tamba Mina Millimouno @MinaTamba, Bruno Meessen @bmeessen, Willem Van De Put @willemvandeput, Bienvenu Salim Camara @salimbienvo, Aiki Christou @alichristou and Alexandre Delamou @Alexdelamou

Acknowledgements We acknowledge support from Delphin Kolie during data collection (survey) and Sory Condé and Tamba Jacques Millimouno from ANSS for clarifying certain information. We are also grateful to health committee members, district medical officers, regional health inspectors, the representative of the national agency for health security, and development partners who participated in the survey.

Contributors TMM, BM and AD conceived the research. TMM designed the research protocol with feedback from MG and WVDP. TMM and BSC performed the reports' selection and appraisal. TMM monitored the online survey, analysed and interpreted both the review and survey findings. TMM drafted the manuscript with inputs from TD, WVDP, AC, BSC, SS and AD, and with critical review from BM. All authors read and approved the final manuscript and AD is responsible for the overall content of the manuscript as guarantor.

Funding This study was not funded. It was conducted as part of the primary author (TMM)'s Master's thesis in public health (orientation: health systems and disease control) at the ITM of Antwerp in Belgium.

Disclaimer The authors alone are responsible for the views expressed in this article, and they do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated.

Map disclaimer The inclusion of any map (including the depiction of any boundaries therein), or of any geographic or locational reference, does not imply the expression of any opinion whatsoever on the part of BMJ concerning the legal status of any country, territory, jurisdiction or area or of its authorities. Any such expression remains solely that of the relevant source and is not endorsed by BMJ. Maps are provided without any warranty of any kind, either express or implied.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable

Ethics approval This research was approved by the National Health Research Ethics Committee of Guinea (N°:021/CNERS/22) and the ITM Institutional Review Board in Belgium (IRB reference code: 1569/22). Written informed consent was obtained from each key informant and preceded the electronic survey questionnaire which was anonymised at the end of the survey.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. All data relevant to the study are included in the article or uploaded as supplementary information.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iDs

Tamba Mina Millimouno <http://orcid.org/0000-0002-4628-1296>

Bruno Meessen <http://orcid.org/0000-0002-0359-8621>

Willem Van De Put <http://orcid.org/0000-0002-3306-5287>

Marlon Garcia <http://orcid.org/0000-0002-9528-2295>

Bienvenu Salim Camara <http://orcid.org/0000-0002-2859-7684>

Aliki Christou <http://orcid.org/0000-0001-9525-8255>

Therese Delvaux <http://orcid.org/0000-0001-6299-2648>

Sidikiba Sidibé <http://orcid.org/0000-0002-7905-9042>

Abdoul Habib Beavogui <http://orcid.org/0000-0003-4950-6224>

Alexandre Delamou <http://orcid.org/0000-0002-9397-7106>

REFERENCES

- Cambridge Dictionary. Learn | définition en anglais [Internet]. n.d. Available: <https://dictionary.cambridge.org/fr/dictionnaire/anglais-britannique-essentiel/learn?q=learning>
- Merriam-Webster Dictionary. Learning definition & meaning [Internet]. n.d. Available: <https://www.merriam-webster.com/dictionary/learning>
- Ambrose SA, Bridges MW, Dipietro M, et al. *7 research-based principles for smart teaching*. San Francisco, California, 2010.
- Mayer RE. Rote versus meaningful learning. *Theory Into Practice* 2002;41:226–32.
- Fiol CM, Lyles MA. Organizational learning. *The Academy of Management Review* 1985;10:803.
- Wikipedia. Learning [internet]. n.d. Available: <https://en.wikipedia.org/wiki/Learning>
- Garvin AD. *Learning in action: a guide to put a learning organisation to work*. Boston, Massachusetts: Harvard Business Review Press, 2000: 221. Available: https://lire.amazon.fr/?asin=B00PSSEJ7O&ref_=kwl_kr_iv_rec_1&language=fr-FR
- Kruk ME, Myers M, Varpilah ST, et al. What is a resilient health system? lessons from ebola. *Lancet* 2015;385:1910–2.
- Bozorgmehr K, Roberts B, Razum O, et al. *Health policy and systems responses to forced migration*. Cham, 2020.
- Sheikh K, Peters D, Agyepong IA, et al. Learning is a means to progress and empowerment for health systems. *BMJ Glob Health* 2022;7:e010572.
- Sheikh K, Abimbola S, Robinson J. Strong health systems are learning health systems. *PLOS Glob Public Health* 2022;2:e0000229.
- Easterling D, Perry AC, Woodside R, et al. Clarifying the concept of a learning health system for healthcare delivery organizations: implications from a qualitative analysis of the scientific literature. *Learn Health Syst* 2022;6:e10287.
- Lattof SR, Maliqi B, Livesley N, et al. National learning systems to sustain and scale up delivery of quality healthcare: a conceptual framework. *BMJ Glob Health* 2022;7:e008664.
- World Health Organization. *Guidance on developing national learning health-care systems to sustain and scale up delivery of quality maternal, newborn and child health care*. Geneva, Switzerland, 2022.
- Akhniif E, Macq J, Idrissi Fakhreddine MO, et al. Scoping literature review on the learning organisation concept as applied to the health system. *Health Res Policy Sys* 2017;15:1–12.
- Akhniif E, Kiendrebéogo JA, Idrissi Azouzzi A, et al. Are our “UHC systems” learning systems? piloting an assessment tool and process in six african countries. *Health Res Policy Syst* 2018;16:78.
- Akhniif E, Macq J, Meessen B. The place of learning in a universal health coverage health policy process: the case of the RAMEC policy in Morocco. *Health Res Policy Sys* 2019;17:1–13.
- Meessen B, Akhniif EH, Kiendrebéogo JA, et al. Learning for universal health coverage. *BMJ Glob Health* 2019;4:e002059.
- Irimu G, Ogero M, Mbevi G, et al. Approaching quality improvement at scale: a learning health system approach in kenya. *Arch Dis Child* 2018;103:1013–9.
- Sheikh K, Abimbola S. Learning health systems: pathways to progress - A flagship report from the alliance for health policy and systems research [Internet]. 2021. Available: <https://ahpsr.who.int/publications/i/item/learning-health-systems-pathways-to-progress>
- Witter S, Sheikh K, Schleiff M. Learning health systems in low-income and middle-income countries: exploring evidence and expert insights. *BMJ Glob Health* 2022;7:e008115.
- Sheikh K, Agyepong I, Jhalani M, et al. Learning health systems: an empowering agenda for low-income and middle-income countries. *Lancet* 2020;395:476–7.
- Kwon S. COVID-19: lessons from south korea | health systems global [internet]. 2020. Available: <https://healthsystemsglobal.org/news/covid-19-lessons-from-south-korea/>
- Oh M-D, Park WB, Park S-W, et al. Middle East respiratory syndrome: what we learned from the 2015 outbreak in the Republic of Korea. *Korean J Intern Med* 2018;33:233–46.
- Lee C, Ki M. Strengthening epidemiologic investigation of infectious diseases in Korea: lessons from the middle East respiratory syndrome outbreak. *Epidemiol Health* 2015;37:e2015040.
- Yang TU, Noh JY, Song JY, et al. How lessons learned from the 2015 middle East respiratory syndrome outbreak affected the response to coronavirus disease 2019 in the Republic of Korea. *Korean J Intern Med* 2021;36:271–85.
- Chua AQ, Al Knawy B, Grant B, et al. How the lessons of previous epidemics helped successful countries fight covid-19. *BMJ* 2021;372:n486.
- Kim J, Ah-Reum An J, Oh S, et al. Emerging COVID-19 success story: south korea learned the lessons of MERS [internet]. our world in data. n.d. Available: <https://ourworldindata.org/covid-exemplar-south-korea>
- Nguyen TV, Tran QD, Phan LT, et al. In the interest of public safety: rapid response to the COVID-19 epidemic in Vietnam. *BMJ Glob Health* 2021;6:e004100.
- Nit B, Samy AL, Tan SL, et al. Understanding the slow COVID-19 trajectory of cambodia. *Public Health Pract (Oxf)* 2021;2:100073.
- Lowe R, Gasparrini A, Van Meerbeeck CJ, et al. Nonlinear and delayed impacts of climate on dengue risk in Barbados: a modelling study. *PLOS Med* 2018;15:e1002613.
- Curatio International Foundation. The COVID-19 epidemic in georgia projections and policy options [internet]. 2020 Available: <http://curatiofoundation.org/covid-19-epidemic-georgia-projections-policy-options/>
- Maxmen A. Deadly lassa-fever outbreak tests Nigeria’s revamped health agency. *Nature* 2018;555:421–2.
- Tom-Aba D, Silenou BC, Doerrbecker J, et al. The surveillance outbreak response management and analysis system (SORMAS): digital health global goods maturity assessment. *JMIR Public Health Surveill* 2020;6:e15860.
- Saleh F, Popoola BO, Arinze C, et al. Adapting public health response through lessons learnt: nigeria’s experience from lassa fever and COVID-19. *BMJ Glob Health* 2022;7:e007993.
- Kothari A, Rudman D, Dobbins M, et al. The use of tacit and explicit knowledge in public health: a qualitative study. *Implement Sci* 2012;7:20.
- Becerril-Montekio V, Alcalde-Rabalan J, Darney BG, et al. Using Systematized tacit knowledge to prioritize implementation challenges in existing maternal health programs: implications for the post mdg era. *Health Policy Plan* 2016;31:1031–8.
- Keugoung B, Bello KOA, Millimouno TM, et al. Mobilizing health district management teams through digital tools: lessons from the district.team initiative in Benin and guinea using an action research methodology. *Learn Health Syst* 2021;5:e10244.
- Husain L. Policy experimentation and innovation as a response to complexity in china’s management of health reforms. *Global Health* 2017;13:54.
- Lowe R, Leslie R, Stewart-Ibarra A. Co-developing a climate-informed dengue early warning system in barbados. *HPSR flagsh rep [internet]*. 2021: 74. Available: <https://ahpsr.who.int/publications/i/item/learning-health-systems-pathways-to-progress>
- Dunlop CA. Policy learning and policy failure: definitions, dimensions and intersections. *Policy Polit* 2017;45:3–18.

- 42 Coordination Nationale de Lutte Contre Ebola et OMS. *Rapport de la situation épidémiologique, maladie à virus ebola en guinée. sit_rep_no 703*. 2016.
- 43 Camara S, Delamou A, Millimouno TM, et al. Community response to the Ebola outbreak: contribution of community-based organisations and community leaders in four health districts in guinea. *Glob Public Health* 2020;15:1767–77.
- 44 Kolie D, Delamou A, van de Pas R, et al. “never let a crisis go to waste”: post-ebola agenda-setting for health system strengthening in guinea. *BMJ Glob Health* 2019;4:e001925.
- 45 Wilkinson A, Parker M, Martineau F, et al. Engaging “communities”: anthropological insights from the west african ebola epidemic. *Philos Trans R Soc Lond B Biol Sci* 2017;372:20160305.
- 46 Millimouno TM, Sidibé S, Delamou A, et al. Evaluation of the maternal deaths surveillance and response system at the health district level in guinea in 2017 through digital communication tools. *Reprod Health* 2019;16:5.
- 47 Yin RK. Design and methods. In: Knight V, Young J, Koscielak K, et al, eds. *Case study research and applications*. Sixth edit. Thousands Oaks, London, New Delhi: Samsung Hub: SAGE Publications, 2018: 432. Available: <https://www.momox-shop.fr/yin-robert-k-case-study-research-and-applications-design-and-methods-taschenbuch-M01506336167.html>
- 48 Institut National de la Statistique. Population guinée (projections 2021) [internet]. n.d. Available: <https://www.stat-guinee.org/>
- 49 Ministère de la Santé. Catalogue des indicateurs sanitaires par domaines - composantes [internet] conakry. 2017. Available: <https://sante.gov.gn/download/catalogue-indicateurs-sanitaires-domaines-composantes/>
- 50 Wikipédia. Agence nationale de la sécurité sanitaire [internet]. 2022. Available: https://fr.wikipedia.org/wiki/Agence_nationale_de_la_sécurité_sanitaire
- 51 Soumah FS, Kaniewski D, Kokou K. Les forêts sacrées de guinée: entre écologie et conservation. *Comptes Rendus Biologies* 2018;341:433–43.
- 52 Yin RK. Design and methods. In: Knight V, Young J, Koscielak K, et al., eds. *Case study research*. Fifth edit. Thousands Oaks, London, New Delhi, Samsung Hub: SAGE Publications, 2014: 403. Available: https://books.google.be/books/about/Case_Study_Research.html?id=FzawlAdilHkC&redir_esc=y
- 53 Yin RK. Design and methods. In: Knight V, Young J, Koscielak K, et al., eds. *Case Study Research*. Fourth edn. Thousands Oaks, London, New Delhi: Samsung Hub, 2009: 219. Available: https://books.google.be/books/about/Case_Study_Research.html?id=FzawlAdilHkC&redir_esc=y
- 54 Silver S. Introduction to mixed methods systematic reviews. In: Francis E, ed. *BI Manual for Evidence Synthesis [Internet]*. JBI, 2020. Available: <https://jbi-global-wiki.refined.site/space/MANUAL/4689215/8.1+Introduction+to+mixed+methods+systematic+reviews>
- 55 Linton NM, Keita M, Moitinho de Almeida M, et al. Impact of mass vaccination campaigns on measles transmission during an outbreak in guinea, 2017. *J Infect* 2020;80:326–32.
- 56 Magassouba N, Koivogui E, Conde S, et al. A sporadic and lethal Lassa fever case in forest guinea, 2019. *Viruses* 2020;12:1062.
- 57 Mari Saez A, Cherif Haidara M, Camara A, et al. Rodent control to fight lassa fever: evaluation and lessons learned from a 4-year study in upper guinea. *PLoS Negl Trop Dis* 2018;12:e0006829.
- 58 Mariën J, Lo Iacono G, Rieger T, et al. Households as hotspots of Lassa fever? assessing the spatial distribution of Lassa virus-infected rodents in rural villages of guinea. *Emerg Microbes Infect* 2020;9:1055–64.
- 59 ANSS. *Guide de gestion multisectorale des zoonoses prioritaires en guinée*. Conakry, Guinea, 2019.
- 60 Ministère de la Santé. *Plan national de préparation et de riposte contre l'épidémie de coronavirus (covid-19)*. Conakry, Guinea, 2020.
- 61 ANSS. *Réponse communautaire stop covid-19 en 60 jours*. Conakry, Guinea, 2020.
- 62 Cellule de Coordination Nationale de Lutte contre Ebola. *Plan stratégique campagne Zéro ebola en 60 jours*. Conakry, Guinea, 2014. Available: <https://www.medbox.org/pdf/5e148832db60a2044c2d2906>
- 63 Impouma B, Williams GS, Moussana F, et al. The first 8 months of COVID-19 pandemic in three west african countries: leveraging lessons learned from responses to the 2014–2016 ebola virus disease outbreak. *Epidemiol Infect* 2021;149:e258.
- 64 Millimouno TM, Ahmed MAA, Ly BA, et al. Evolution of the COVID-19 pandemic over six weeks in four french-speaking countries in west africa. *J Glob Health* 2021;11:03008.
- 65 Adote KA. How effective are african health systems? an analysis of guinea, liberia and sierra leone [Internet]. 2020. Available: https://digitalcommons.lasalle.edu/honors_projects/40
- 66 Kolie D, Van De Pas R, Fofana TO, et al. Guinea's response to syndemic hotspots. *BMJ Glob Health* 2021;6:e006550.
- 67 Maxmen A. Ebola prepared these countries for coronavirus-but now even they are floundering. *Nature* 2020;583:667–8.
- 68 Delamou A, Sidibé S, Camara A, et al. Tackling the COVID-19 pandemic in West Africa: have we learned from Ebola in guinea? *Prev Med Rep* 2020;20:101206.
- 69 Delamou A, Millimouno TM, Dioubate N, et al. Effect of COVID-19 on maternal and neonatal healthcare services in guinea: a hospital based study. *Eur J Public Health* 2021;31:ckab164.158.
- 70 Ministère de la Santé. *Plan de Réponse à la maladie à virus ebola en guinée*. Conakry, Guinea, 2021.
- 71 Organisation Mondiale de la Santé. *Déclaration de la fin de l'épidémie ebola en guinée*. Conakry: OMS, 2021: 1–7. Available: <https://www.afro.who.int/fr/news/declaration-de-la-fin-de-lepidemie-ebola-en-guinee>
- 72 ANSS. *Plan des 90 jours de la surveillance renforcée en guinée (20 juin au 20 septembre 2021)*. Conakry, 2021.
- 73 Keita AK, Koundouno FR, Faye M, et al. Resurgence of Ebola virus in 2021 in guinea suggests a new paradigm for outbreaks. *Nature* 2021;597:539–43.
- 74 ANSS. *Plan de riposte marburg*. Conakry, Guinea, 2021.
- 75 Organisation Mondiale de la Santé. *Marburg riposte: rapport sur les interventions de l'OMS guinée*. Conakry, Guinea, 2021.
- 76 Organisation Mondiale de la Santé. *En guinée, la flambée de maladie à virus marburg a été rapidement endiguée*. OMS, 2021. Available: <https://www.afro.who.int/fr/news/en-guinee-la-flambée-de-maladie-virus-marburg-ete-rapidement-endiguee>
- 77 Aborode AT, Wireko AA, Bel-Nono KN, et al. Marburg virus amidst COVID-19 pandemic in guinea: fighting within the looming cases. *Int J Health Plann Manage* 2022;37:553–5.
- 78 World Health Organisation. *Guinea declares end of marburg virus disease outbreak*. OMS, 2021. Available: <https://www.afro.who.int/news/guinea-declares-end-marburg-virus-disease-outbreak>
- 79 Argyris C. Double loop learning in organizations [Internet]. 1977. Available: <https://www.avannistelrooij.nl/wp/wp-content/uploads/2017/11/Argyris-1977-Double-Loop-Learning-in-Organisations-HBR.pdf>
- 80 Bateson G. Collected essays in anthropology, psychiatry, evolution, and epistemology [Internet]. In: Caroll V, ed. *Steps to an ecology of mind*. London: Jason Aronson Inc, 1972: 1–535. Available: <https://ejc.orfaleacenter.ucsb.edu/wp-content/uploads/2017/06/1972.-Gregory-Bateson-Steps-to-an-Ecology-of-Mind.pdf>
- 81 Pfeffer J, Sutton RI. *The knowing-doing gap: how smart companies turn knowledge into action*. First eBoo. Cambridge: Harvard Business Press, 1999: 336. Available: https://books.google.com/books/about/The_Knowing_Doing_Gap.html?hl=fr&id=wpSP2eA6a9cC
- 82 Azimi A, Fattahi R, Asadi-Lari M. Knowledge translation status and barriers. *J Med Libr Assoc* 2015;103:96–9.
- 83 Graham ID, Logan J, Harrison MB, et al. Lost in knowledge translation: time for a MAP? *J Contin Educ Health Prof* 2006;26:13–24.
- 84 Keita M, Talisuna A, Chamla D, et al. Investing in preparedness for rapid detection and control of epidemics: analysis of health system reforms and their effect on 2021 Ebola virus disease epidemic response in guinea. *BMJ Glob Health* 2023;8:e010984.
- 85 Keita S. *Ma lutte contre ebola en republique de guinée*. Harmattan, Paris, 2021. Available: https://www.editions-harmattan.fr/livre-ma_lutte_contre_ebola_en_republique_de_guinee_sakoba_keita-9782343224770-69487.html
- 86 ANSS. *Célébration de l'an un de l'Agence nationale de Sécurité sanitaire*. ANSS, 2020. Available: <https://anss-guinee.org/welcome/detailNew/28>
- 87 Reynolds E, Martel LD, Bah MO, et al. Implementation of DHIS2 for disease surveillance in guinea: 2015–2020. *Front Public Heal* 2022;9:2260.
- 88 Hemingway-Foday JJ, Diallo BI, Compaore S, et al. Lessons learned for surveillance system strengthening through capacity building and partnership engagement in post-ebola guinea, 2015–2019. *Front Public Health* 2022;10:715356.
- 89 Dooley J. Problem-solving as a double-loop learning system. 1999. Available: <http://citeserx.ist.psu.edu/viewdoc/download?doi=10.1.1.35.44&rep=rep1&type=pdf>
- 90 Christensen CM, Overdorf M. Meeting the challenge of disruptive change. 2000. Available: www.hbr.org

- 91 Argyris C. Double-loop learning and implementable validity. In: *Organizations as knowledge systems*. London: Palgrave Macmillan UK, 2004: 29–45.
- 92 Argyris C, Schön D. *Organizational learning II: theory, method, and practice*. Cambridge: Financial Times/ Prentice Hall, 1995: 336. Available: https://www.amazon.fr/gp/product/0201629836/ref=db_s_a_def_rwt_bibl_vppl_i10
- 93 Rajan D, Mathurapote N, Putthasri W, et al. Institutionalising participatory health governance: lessons from nine years of the national health assembly model in thailand. *BMJ Glob Health* 2019;4:e001769.
- 94 District.Team. Mobilisation 2.0 des équipes cadres de district [Internet]. n.d. Available: <http://guinee.district.team/>
- 95 Cronin G, Andrews S. After action reviews: a new model for learning. *Emerg Nurse* 2009;17:32–5.
- 96 Tosey P, Visser M, Saunders MNK. The origins and conceptualizations of 'triple-loop' learning: A critical review. *Manag Learn* 2012;43:291–307.
- 97 Peschl M. Triple-loop learning as foundation for profound change, individual cultivation, and radical innovation: construction processes beyond scientific and rational knowledge. *Constr Found* 2006;2:136–45.
- 98 Mo S. Organizational learning process in single, double and triple loop companies in a post-crisis situation in the textile sector in tunisia. *J Entrepren Organiz Manag* 2017;6:219.
- 99 Fahrenbach F, Kragulj F. The ever-changing personality: revisiting the concept of triple-loop learning. *TLO* 2022;29:499–512.
- 100 Gould J, Dibella A, Nevis E. *The systems thinker – organizations as learning systems*. The Systems Thinker, 2018: 1. Available: <https://thesystemsthinker.com/organizations-as-learning-systems/>
- 101 Straus SE, Tetroe J, Graham I. Defining knowledge translation. *CMAJ* 2009;181:165–8.
- 102 Mickan S. Using knowledge to action practice change [Internet]. 2014. Available: <https://www.cebm.net/wp-content/uploads/2014/07/Using-knowledge-to-action-practice-change.pdf>
- 103 Crossan MM, Lane HW, White RE. An organizational learning framework: from intuition to institution. *The Academy of Management Review* 1999;24:522.
- 104 Marsick VJ, Watkins KE. Demonstrating the value of an organization's learning culture: the dimensions of the learning organization questionnaire. *Advances in Developing Human Resources* 2003;5:132–51.
- 105 Kim K, Watkins KE, Lu Z. The impact of a learning organization on performance: focusing on knowledge performance and financial performance. *Eur J Train Dev* 2017;41:177–93.
- 106 Argyris C, Schön D. *Organizational learning: A theory of action perspective*. Cambridge: Addison Wesley Longman Publishing Co., 1978: 356. Available: https://books.google.be/books/about/Organizational_Learning.html?id=2aYOAQAAMAAJ&redir_esc=y
- 107 Snell R, Chak AMK. The learning organization: learning and empowerment for whom? *Management Learning* 1998;29:337–64.
- 108 Stiglitz JE. Information and the change in the paradigm in economics [Internet]. 2001. Available: <http://www.jstor.org/stable/3083351>
- 109 Jenkin TA. Extending the 4i organizational learning model: information sources, foraging processes and tools. *Administrative Sciences* 2013;3:96–109.
- 110 Nevis EC, DiBella AJ, Gould JM. Understanding organizations as learning systems [Internet]. 1995. Available: <https://sloanreview.mit.edu/article/understanding-organizations-as-learning-systems/>
- 111 Schilling L, Dearing JW, Staley P, et al. Kaiser permanente's performance improvement system, part 4: creating a learning organization. *Jt Comm J Qual Patient Saf* 2011;37:532–43.
- 112 Hayek FA. The use of knowledge in society. *Am Econ Rev* 1945;35:1–10.
- 113 McCoy ML, Scully PL. Deliberative dialogue to expand civic engagement: what kind of talk does democracy need? *Nat Civic Rev* 2002;91:117–35.
- 114 George C. Retaining professional workers: what makes them stay? *Employee Relations* 2015;37:102–21.
- 115 Abimbola S. Health system governance: a triangle of rules. *BMJ Glob Health* 2020;5:e003598.
- 116 Lazonick W, Brush T. The "horndog effect" in early U.S. manufacturing. *Explorations in Economic History* 1985;22:53–96.
- 117 Levitt SD, List JA, Syverson C. *Toward an understanding of learning by doing: evidence from an automobile assembly plant. report no.: 18017*. Cambridge, 2012. Available: <http://www.nber.org/papers/w18017%0ANATIONAL>
- 118 Hendel I, Spiegel Y. Small steps for workers, a giant leap for productivity. *American Economic Journal: Applied Economics* 2014;6:73–90. 10.1257/app.6.1.73 Available: www.csio.econ.northwestern.edu
- 119 Stern C, Lizarondo L, Carrier J, et al. Methodological guidance for the conduct of mixed methods systematic reviews. *JBI Evid Synth* 2020;18:2108–18.
- 120 Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71.
- 121 Booth A, Noyes J, Flemming K, et al. Formulating questions to explore complex interventions within qualitative evidence synthesis. *BMJ Glob Health* 2019;4:e001107.
- 122 Rayyan. Intelligent systematic review [Internet]. n.d. Available: <https://www.rayyan.ai/>
- 123 Grant MJ, Booth A. A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Info Libr J* 2009;26:91–108.
- 124 Wright KB. Researching internet-based populations: advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services. *J Comput Mediat Commun* 2005;10.
- 125 Ilieva J, Baron S, Healey NM. Online surveys in marketing research. *International Journal of Market Research* 2002;44:1–14.
- 126 KoBoToolbox. Data collection tools for challenging environments. 2022. Available: <https://www.kobotoolbox.org/>
- 127 Patton MQ. *Qualitative research and evaluation methods: theory and practice*. Fourth ed. SAGE Publications, Inc, 2015: 832. Available: <https://us.sagepub.com/en-us/nam/qualitative-research-evaluation-methods/book232962#description>
- 128 Gillespie AM, Obregon R, El Asawi R, et al. Social mobilization and community engagement central to the Ebola response in West Africa: lessons for future public health emergencies. *Glob Health Sci Pract* 2016;4:626–46.
- 129 Kodish SR, Rohner F, Beauliere J-M, et al. Implications of the Ebola virus disease outbreak in guinea: qualitative findings to inform future health and nutrition-related responses. *PLoS ONE* 2018;13:e0202468.
- 130 Baldé T. Response to the Ebola epidemics in guinea: public health organisational issues and possible solutions. *African Evaluation Journal* 2015;3.
- 131 Bjorneseth F, Boas M, Erstad H. KO-NC-19, U. lessons from the ebola crisis in west africa: community engagement, crisis communication and countering rumours [internet]. 2020. Available: <https://nupi.brage.unit.no/nupi-xmlui/handle/11250/2653253>
- 132 Scott V, Crawford-Browne S, Sanders D. Critiquing the response to the Ebola epidemic through a primary health care approach. *BMC Public Health* 2016;16:410.
- 133 Karamouzian M, Hategekimana C. Ebola treatment and prevention are not the only battles: understanding ebola-related fear and stigma. *Int J Health Policy Manag* 2015;4:55–6.
- 134 Jalloh MF, Bunnell R, Robinson S, et al. Assessments of ebola knowledge, attitudes and practices in forécariah, guinea and kambia, sierra leone, july-august 2015. *Philos Trans R Soc Lond B Biol Sci* 2017;372:1721.
- 135 Laverack G, Manoncourt E. Key experiences of community engagement and social mobilization in the Ebola response. *Glob Health Promot* 2016;23:79–82.
- 136 Miller NP, Milsom P, Johnson G, et al. Community health workers during the ebola outbreak in guinea, liberia, and sierra leone. *J Glob Health* 2018;8:020601.
- 137 Keita M, Conté F, Diallo B, et al. Lessons learned by surveillance during the tail-end of the Ebola outbreak in guinea, june-october 2015: a case series. *BMC Infect Dis* 2017;17:304.
- 138 Bhatnagar N, Grover M, Kotwal A, et al. Study of recent Ebola virus outbreak and lessons learned: a scoping study. *Ann Trop Med Public Health* 2016;9:145.
- 139 Delamou A, Delvaux T, El Ayadi AM, et al. Public health impact of the 2014–2015 Ebola outbreak in West Africa: seizing opportunities for the future. *BMJ Glob Health* 2017;2:e000202.
- 140 Ibrahim U, Farouk Ismail U. Ebola outbreak in west africa and csos response. *CARD Int J Med Sci Appl Biosci* 2016;1:2536–734.
- 141 Govindaraj R, Herbst C. *Strengthening post-ebola health systems: from response to resilience in guinea, liberia, and sierra leone*. Washington DC: World bank group, 2017: 1–141. Available: <https://books.google.com/books?hl=fr&lr=&id=2bZEDwAAQBAJ&oi=fnd&pg=PT9&dq=Guinea+learning+%2522Ebola+Virus%2522+OR+%2522Hemorrhagic+Fever+Ebola%2522+OR+%2522Lassa+Fever%2522+OR+Measles+OR+%2522Yellow+Fever%2522+OR+Poliomyelitis+OR+Meningitis+OR+%2522Marbu>
- 142 Sidibé S, Camara BS, Delamou A, et al. Knowledge, attitudes and practices of healthcare providers on suspected ebola cases in guinea. *Rev Epidemiol Sante Publique* 2018;66:369–74.

- 143 Soeters HM, Koivogui L, de Beer L, *et al.* Infection prevention and control training and capacity building during the Ebola epidemic in guinea. *PLoS One* 2018;13:e0193291.
- 144 Jaye T, -Afful FE. Ebola: impact and lessons for west africa [Internet]. 2014. Available: <https://www.africaportal.org/publications/ebola-impact-and-lessons-for-west-africa/>
- 145 Undurraga EA, Carias C, Meltzer MI, *et al.* Potential for broad-scale transmission of Ebola virus disease during the West Africa crisis: lessons for the global health security agenda. *Infect Dis Poverty* 2017;6:1–10.
- 146 Fairhead J. Understanding social resistance to the Ebola response in the forest region of the Republic of guinea: an anthropological perspective. *Afr Stud Rev* 2016;59:7–31.
- 147 Vetter P, Dayer J-A, Schibler M, *et al.* The 2014–2015 Ebola outbreak in West Africa: hands on. *Antimicrob Resist Infect Control* 2016;5.
- 148 Kekulé AS. Learning from Ebola virus: how to prevent future epidemics. *Viruses* 2015;7:3789–97.
- 149 Venables E, Pellecchia U. Engaging anthropology in an ebola outbreak: case studies from west africa. *Anthropol Action* 2017;24:1–8.
- 150 Lesho EP. Editorial commentary: fighting Ebola and advancing knowledge on the front lines in a capital City. *Clin Infect Dis* 2015;60:1825–7.
- 151 Magassouba AS, Diallo BD, Camara LM, *et al.* Impact of the Ebola virus disease outbreak (2014–2016) on tuberculosis surveillance activities by guinea's national tuberculosis control program: a time series analysis. *BMC Public Health* 2020;20:1200.
- 152 Kolie D, Camara BS, Delamou A, *et al.* The ebola-effect in guinea 2014–15: tangled trends of malaria care in children under-five. *PLoS One* 2018;13:e0192798.
- 153 Leno NN, Delamou A, Koita Y, *et al.* Ebola virus disease outbreak in guinea: what effects on prevention of mother-to-child transmission of HIV services? *Reprod Health* 2018;15:60.
- 154 Plucinski MM, Guilavogui T, Sidikiba S, *et al.* Effect of the ebola-virus-disease epidemic on malaria case management in guinea, 2014: a cross-sectional survey of health facilities. *Lancet Infect Dis* 2015;15:1017–23.
- 155 Delamou A, Ayadi AME, Sidibe S, *et al.* Effect of ebola virus disease on maternal and child health services in guinea: a retrospective observational cohort study. *Lancet Glob Health* 2017;5:e448–57.
- 156 Moisan F, Traore A, Zoumanigui D, *et al.* Public health structures attendance during the Ebola outbreak in guéckédou, guinea. *Epidemiol Infect* 2016;144:2338–44.
- 157 Camara BS, Okumura J, Delamou A. Do memories of the Ebola virus disease outbreak influence post-ebola health seeking behaviour in guéckédou district (epicentre) in guinea? A cross-sectional study of children with febrile illness. *BMC Public Health* 2020;20:1298.
- 158 Lebel R. Ebola outbreak in guinea. In: Halpern J, Nitzza A, Vermeulen K, eds. *Disaster Mental Health Case Studies: Lessons Learned from Counseling in Chaos* [Internet]. New York: Routledge, 2019. Available: https://play.google.com/store/books/details?id=0OelDwAAQBAJ&rdid=book-0OelDwAAQBAJ&rdot=1&source=gbs_vpt_read&pcampaignid=books_booksearch_viewport
- 159 Gsell P-S, Camacho A, Kucharski AJ, *et al.* Ring vaccination with rsv-ZEBOV under expanded access in response to an outbreak of ebola virus disease in guinea, 2016: an operational and vaccine safety report. *Lancet Infect Dis* 2017;17:1276–84.
- 160 Diallo B, Sissoko D, Loman NJ, *et al.* Resurgence of Ebola virus disease in guinea linked to a survivor with virus persistence in seminal fluid for more than 500 days. *Clin Infect Dis* 2016;63:1353–6.
- 161 Mamoudou BE, Sory DI, Saidou D, *et al.* Obstetrical surgery in the context of Ebola virus disease (Ebola) in guinea: lessons learned from 2 cases. *OJOG* 2019;09:1305–14.
- 162 Pini A, Zomahoun D, Duraffour S, *et al.* Field investigation with real-time virus genetic characterisation support of a cluster of ebola virus disease cases in dubréka, guinea, april to june 2015. *Euro Surveill* 2018;23:17-00140.
- 163 Dhillon RS, Kelly JD. Community trust and the Ebola endgame. *N Engl J Med* 2015;373:787–9.
- 164 Keita M, Keita S, Diallo B, *et al.* Public health program for decreasing risk for Ebola virus disease resurgence from survivors of the 2013–2016 outbreak, guinea. *Emerg Infect Dis* 2020;26:206–11.
- 165 Pastor Institute. Ebola 2013–2016: lessons learned and how to respond to new epidemics [internet]. 2017. Available: <https://www.pasteur.fr/en/home/research-journal/reports/ebola-2013-2016-lessons-learned-and-how-respond-new-epidemics>
- 166 Keita M, Cherif MS, Sivaheha B, *et al.* Case report: COVID-19 and lassa fever coinfection in an ebola suspected patient in guinea. *Am J Trop Med Hyg* 2022;106:1094–7.
- 167 Kpanake L, Dounamou T, Sorum PC, *et al.* What motivates individuals to volunteer in Ebola epidemic response? a structural approach in guinea. *Hum Resour Health* 2019;17:81.
- 168 Ministère de la Santé. Plan de relance et de résilience du système de santé 2015–2017 [internet] conakry. 2015. Available: https://portail.sante.gov.gn/wp-content/uploads/2019/10/Plan_Relance-Résilience_Système_Santé_2015-2017-Août-2015.pdf
- 169 Millimouno TM, Delamou A, Kourouma K, *et al.* Outcomes of blended learning for capacity strengthening of health professionals in guinea. *BMC Med Educ* 2021;21:406.
- 170 Millimouno TM, Delvaux T, Kolié JM, *et al.* Evaluation of three blended learning courses to strengthen health professionals' capacity in primary health care, management of sexual and reproductive health services and research methods in guinea. *Front Digit Health* 2022;4:911089.
- 171 Millimouno TM, Delamou A, Kourouma K, *et al.* Approche elearning pour Le renforcement des capacités des professionnels de santé en guinée: une expérience post-ebola. *Santé Publique* 2021;Vol. 32:537–48.
- 172 Ndjomou J, Shearer S, Karlstrand B, *et al.* Sustainable laboratory capacity building after the 2014 ebola outbreak in the republic of guinea. *Front Public Health* 2021;9:659504.
- 173 Snowden D, Boone M. *A leader's framework for decision making* [Internet]. 2007: 23. Available: <https://hbr.org/2007/11/a-leaders-framework-for-decision-making>
- 174 Kurtz CF, Snowden DJ. The new dynamics of strategy: sense-making in a complex and complicated world. *IBM Syst J* 2003;42:462–83.
- 175 Holly M, Bartels S, Lewis N, *et al.* A learning approach to community response during the COVID-19 pandemic: applying the cynefin framework to guide decision-making. *Learn Health Syst* 2022;6:e10295.
- 176 Cambridge Dictionary. Experience [internet]. 2022. Available: <https://dictionary.cambridge.org/fr/dictionnaire/anglais-britannique-essentiel/experience>