

Realist Evaluation of the Integrated Electronic Diagnosis Approach (leDA) for the Management of Childhood Illnesses at Primary Health Facilities in Burkina Faso

Karl Blanchet (✉ karl.blanchet@unige.ch)

London School of Hygiene & Tropical Medicine <https://orcid.org/0000-0003-0498-8020>

Vincent-Paul Sanon

Centre MURAZ

Sophie Sarrassat

London School of Hygiene & Tropical Medicine

Arsène Satouro Somé

Centre MURAZ

Research

Keywords: Electronic Computer-based Decision Support System, organisational change, innovation, digital health, child health, primary health care, clinical protocol

DOI: <https://doi.org/10.21203/rs.3.rs-71505/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background: Effective implementation of Integrated Management of Childhood Illnesses (IMCI) is often constrained by poor adherence to the guidelines. Burkina Faso introduced the IMCI strategy in 2003 but has suffered from limited implementation of the basic IMCI training and poor adherence to the algorithm. In 2014, Terre des Hommes (TdH), a Swiss non-governmental organisation, together with the Ministry of Health (MoH), launched the Integrated electronic Diagnosis Approach (leDA) intervention in public primary health centres, in two regions of Burkina Faso, consisting of supplying every health centre with a digital algorithm. A realistic evaluation was conducted to understand the implementation process, the mechanisms by which the leDA intervention lead to change and to identify factors that may affect these mechanisms at health centre and community levels.

Methodology: A realistic evaluation method was adopted. Data collection that took place between January 2016 and October 2017. Direct observation in health centres generated elements of information that helped to identify new issues or verify assumptions. The analysis of project reports from health facilities helped analyse the implementation of leDA and the vision of the project by managers. In addition, interviews and focus group discussions provided evidence in relation to the perceptions, in-depth opinions and understandings of actors intervening in leDA. In-depth interviews were conducted with 154 individuals including 92 healthcare workers from health centres, 16 officers from district health authorities, 6 members of health centre management committees. In addition, 5 focus groups (on average 11 people per group) were organised with mothers and carers. The initial coding was based on a preliminary list of codes inspired by the Middle Range Theory and on additional ideas that emerged from the fieldwork. In a second round of analysis, additional themes and patterns emerged.

Results: Our results showed that the adoption of the electronic protocol depended on a multiplicity of management practices including role distribution, team work, problem solving approach and task monitoring and training, supervision, support and recognition. Based on the mechanism of perceived organisational support, such combinations lead to a reorganisation of the health team and the distribution of roles before and during the consultation, and positive atmosphere that includes recognition of each team member, organisational commitment and sense of belonging. Every new comer starting in the health centre or the district are fully integrated into this new organisational culture and benefit from the same support and recognition. Conditions for such management changes to work include open dialog at all levels of the system, a minimum of resources to cover the support services and supervision and regular discussions focusing on solving problems faced by health centre teams.

Conclusion: This project reinforces the point that in a successful diffusion of leDA, it is necessary to combine the introduction of technology with support and management mechanisms. It also shows that in management of healthcare workers, it is important to mix different management practices. It also important to highlight that managers' attitude plays a great place in the success of the intervention: open dialog and respect are crucial dimensions. This is aligned with the findings from other studies.

Contribution To The Literature

- A computer-based protocol is adopted when perceived by users and district managers as being encompassed within a broader quality improvement strategy
- The introduction of such innovation needs to occur in an environment flexible enough to provide space to staff make decisions on the distribution of clearly-defined tasks within the team
- The introduction of the REC needs to be accompanied by a supportive atmosphere and environment (including community and policy makers support)
- Successful diffusion of innovations requires combining the introduction of technology and support and management mechanisms.
- In management of healthcare workers, it is important to mix different management practices.
- Health centre managers' attitude plays a great place in the success of the intervention: open dialog and respect are crucial dimensions.

Introduction

Despite a large reduction in under-five child mortality (from 180 per 1,000 live births in 1990 to 83 per 1,000 live births in 2015), sub-Saharan Africa failed to reach Millennium Development Goal 4 target of 60 deaths per 1,000 live births (United Nations Inter-Agency Group for Child Mortality Estimation 2015). In 1999, the World Health Organisation (WHO) developed the Integrated Management of Childhood Illness strategy (IMCI) (Black, Morris et al. 2003). This strategy provides an algorithm to guide health workers through a systematic clinical assessment of sick children with the aim of improving the diagnostic classification and the treatment of these children (Boss, Toole et al. 1994, Nguyen, Leung et al. 2013, Rakha, Abdelmoneim et al. 2013) and hence reducing mortality (Jones, Steketee et al. 2003, Rakha, Abdelmoneim et al. 2013).

However, effective implementation of IMCI is often constrained by poor adherence to the guidelines (Bryce, Victora et al., Derenzi, Parikh et al. 2008, Horwood, Voce et al. 2009). Previous studies reported that adherence to the guidelines decreases over time due to inadequate initial training, shortage of staff and insufficient supervision (Chaudhary, Mohanty et al. 2005, Rowe, Onikpo et al. 2010).

Burkina Faso introduced the IMCI strategy in 2003. An evaluation conducted in 2013 found that only 24% of nurses working in primary care facilities had been trained in IMCI (Kouanda and Baguiya 2013). Only 28% of children were assessed for three danger signs, and only 15% of children were correctly classified (Kouanda and Baguiya 2013). On average only six out of ten recommended tasks were performed. Only 28% of children were checked for three danger signs, and 40% of children judged to require referral by an IMCI expert were referred by HCWs. While 91% of children with uncomplicated malaria received an ACT, only 34% of children with pneumonia were correctly prescribed antibiotics and only 30% of children with diarrhoea were correctly prescribed Oral Rehydration Salt (ORS).

In 2014, Terre des Hommes (TdH), a Swiss non-governmental organisation, together with the Ministry of Health (MoH), launched the Integrated electronic Diagnosis Approach (leDA) intervention with the objective of improving adherence to IMCI guidelines in public primary health centres, in two regions of Burkina Faso. The IMCI project was implemented at the primary health care level in health centre (Centre de Santé et de Promotion Sociale (CSPS)).

The leDA intervention was evaluated using a mixed-methods study design composed of the following three interlinked studies (Blanchet, Lewis et al. 2016): (i) a stepped-wedge trial to evaluate the effect of leDA on adherence to IMCI guidelines in primary health facilities (give the reference); (ii) a cost-effectiveness analysis (CEA) to assess the value for money of the delivery of leDA; and (iii) a realistic evaluation to understand the implementation process, the mechanisms by which the leDA intervention leads to change and to identify factors that may affect these mechanisms at health centre and community levels.

The stepped wedge trial showed that on average, 54% and 79% of clinical assessment tasks were observed to be completed by health care workers in the control and intervention districts respectively (cluster-level mean difference = 29.9%; P-value = 0.002). The proportion of children benefiting from correct classifications (ignoring the severity) was 73% and 79% in the control and intervention districts respectively (cluster-level mean difference = 10.1%; P-value = 0.004). The proportion of children who received correct prescriptions in accordance with healthcare workers' classifications were similar across arms, 78% in the control arm and 77% in the intervention arm (cluster-level mean difference = -1.1%; P-value = 0.788). The leDA intervention improved substantially HCWs' adherence to IMCI's clinical assessment tasks, leading to some overall increase in correct classifications but to little or no improvement in correct prescriptions.

Here, we report on the results of the realistic evaluation that was conducted alongside the stepped wedge trial. The study's theoretical framework integrates various components, including the four areas that play a role in protocol-based care in general and related impact on stakeholder outcomes: patients, health staff, service providers and policy makers:

1. What are the properties of the leDA tool?
2. How is the approach implemented and the tool used?
3. What is the impact of the approach and its unintended consequences?

Methodology

Setting

The primary health care centres in Burkina Faso deliver a minimum package of services defined by the Ministry of Health comprising both preventive (e.g. vaccinations, antenatal care, health education, and promotion of recommended nutrition, hygiene and safe water family behaviours) and curative measures (e.g. treatment of common illnesses, minor surgery, supply of essential medicine, maternal and child

consultations). The district health management team is in charge of supervising CSPs and reporting routine data collected in them (Ministère de la Santé 2011).

The leDA intervention

The leDA intervention comprised five components: 1. An electronic Computer-based Decision Support System (eCDSS) provided on tablets to primary health facilities and guiding HCWs through the IMCI national protocol during under-five consultations, from the clinical assessment of the child, through the classification, prescription, referral and counselling. During the trial period, several versions of the software were deployed following feedback from users and stakeholders (patients, health staff, service providers and policy makers (Ministry of Health, Tdh)); 2. A six-day training course provided to HCWs on IMCI guidelines and the use of the eCDSS. During the last year of the trial, electronic learning modules with short videos were also available on tablets to support continuous training; 3. A quality assurance coaching system involving team meetings, two to four times a year, through which health district authorities and HCWs discussed solutions to their local issues (e.g. organisation of care); 4. A supervision system including monthly visits by district management team to primary health facilities; 5. A health information system based on data collected through the eCDSS. During the last year of the trial, descriptive dashboards on under-five consultations were developed and shared with the health district authorities and HCWs.

Principles of realist evaluation

Realist evaluation is used to explain 'what works, for whom and in what circumstances. For Pawson and Tilley (1997), 'what works' is not of itself a helpful question as: 'programs work (have successful 'outcomes') only insofar as they introduce the appropriate ideas and opportunities ('mechanisms') to groups in the appropriate social and cultural conditions ('contexts')'.

The task for the researcher is to distil the key potential mechanisms and contexts and examine how they interact in practice. That consist of theorising possible C + M = combinations and explore the ways in which real-life experiences reflect and differ from these theories. The evaluation environment we are working in is one in which relatively little is known about 'what works in what circumstances' in relation to the use of the electronic computer-based decision support systems. Therefore, a core task for the research is to draw on existing data to theorise what seem to be likely 'change mechanisms' and to use the empirical study to explore the presence or otherwise of these C + M configurations (Middle Range Theories), to examine the nature of their interaction and their consequences, both in terms of outcomes but also in terms of facilitating greater awareness of sustainability issues.

Formulation of our Middle Range Theory (MRT)

We formulated our MRT on the basis of an explorative study of the pilot districts where leDA was first tested. During this pilot study, interviewees indicated the importance of the characteristics of the innovation as a driver for use and the importance of the facility setting as a physical and organisational

structure. We also found indications that the perception by communities was a determinant factor that influenced health providers' behaviour to adopt and use leDA.

A second source of inspiration was the realist synthesis of 36 peer-reviewed papers we conducted on the factors influencing the use of eCDSS. It highlighted the interrelation between the properties of the innovation itself with the organisational environment. The contextual factors identified that influenced negatively the use of eCDSS were: financial incentives; competing programmes; previous knowledge and use of IT; high clinician turnover; link of eCDSS to an ordering system; and individual patient preferences for treatment. The complexity, lack of a relative advantage, and incompatibility of eCDSS with workflow, current practice and beliefs of clinicians was associated with low use of eCDSS. Trialability and change valence did not influence eCDSS use.

The innovation attributes

Health systems are viewed as complex systems (Institute of Medicine 2001, Plsek and Greenhalgh 2001). Complex systems are systems with a high number of elements or actors that interact with each other in ways that are not always predictable following the introduction of an innovation (e.g. a new health intervention) (Borgatti, Everett et al. 1990, Rihani 2002).

Diffusion of innovation theory can help explain how the continuation of activities is related to the attributes of activities as innovations. Beyond the description of an innovation as a newness, Rogers (1995) showed that innovations are characterised by five attributes:

1. relative advantage - individuals assess innovations by comparing the expected advantage of the new initiative with the benefits provided by the previous one that it replaced;
2. compatibility - an innovation is perceived as compatible when the new idea or technology introduced by the innovation is consistent with the mandate of the adopters or the adopting system and does not require significant modifications from the adopters (Aubert and Hamel 2001, Denis, Hebert et al. 2002);
3. complexity - the perceived difficulty in understanding a new idea or using a new technology. A complex innovation can also be an intervention which involves a high number of actors (Grilli and Lomas 1994, Denis, Hebert et al. 2002);
4. triability - the notion that an innovation can be tested on a small scale (Yetton, Sharma et al. 1999); and
5. observability - the degree to which the results of the innovation are visible (Grilli and Lomas 1994, Rogers 1995).

Data collection

Various sources of data were used by the investigator during data collection that took place between January 2016 and October 2017. Direct observation in health centres generated elements of information that helped to identify new issues or verify assumptions. The analysis of project reports from health

facilities helped analyse the implementation of leDA and the vision of the project by managers. In addition, interviews and focus group discussions provided evidence in relation to the perceptions, in-depth opinions and understandings of actors intervening in leDA.

In-depth interviews were conducted with 154 individuals including 92 healthcare workers from health centres, 16 officers from district health authorities, 6 members of health centre management committees, 9 child’s caretakers/mothers. In addition, 5 focus groups (on average 11 people per group) were organised with mothers and carers.

Table 1
Number and profile of individuals interviewed during the realistic evaluation

Profile	Number
Healthcare workers	92
Health district officers	16
COGES	6
Child’s caretakers/ mothers	5 Focus group discussions, 9 individual interviews
Drug stock managers	3
Village representatives	2
Community health workers	6
Regional health authority	1
Health centre maintenance officer	2
Traditional chief	2
MoH Officers	6
TDH	3
Total	154 Interviews + 5 focus group discussions

The sampling procedure was chosen according to the objectives of the study: generating theories and concepts rather than generalising findings to a wider population. Therefore, a purposive rather than a probabilistic sampling method was deliberately used by the investigator (Patton 1999, Bowling and Ebrahim 2005). Purposive sampling is used when researchers “seek out groups, settings and individuals where ... the processes being studied are most likely to occur” (Denzin and Lincoln 1994 p. 202).

Data analysis

The initial coding of data collected through interviews, focus group discussions and review of documents was based on a preliminary list of codes inspired by the MRT and on additional ideas that emerged from

the fieldwork. In a second round of analysis, some themes and patterns emerged. In order to structure them as CMO configurations, we found it useful to borrow categories from theory-driven evaluation (Chen 1990). We described the intervention in terms of content and application, and the intended and actual outcomes. We drew on our interviews, observations and document analysis to differentiate the vision (what the team wants), the discourse (what they say) and the actual practice (what they do). We described the organisational climate perceived by staff in terms of procedures, structures and incentives (Schneider, Gunnarson et al. 2004). In order to indicate how the intervention worked, we analysed both the context and the intervening mechanisms and attempted to identify the essential conditions.

Results

Results are reported in terms of actual intervention, policy context, and the innovation attributes.

The actual intervention

Based on the analysis of interviews and project documents, we found that the list of intervention components that really constituted what the intervention was about went beyond the original vision. The project has been very dynamic experiencing several stages of changes mainly guided by the feedbacks received from users. Tdh has put in place regular dialog mechanisms with healthcare staff in order to ensure that the evolution of the tool and project take into account users' feedback.

Between May 2015 and December 2017, the intervention evolved. Several activities and tools were added during the last year primarily to improve knowledge and data use for management and clinical care: (i) development of dashboards at health centre level; (ii) supply of a second tablet to larger health centres; and (iii) online learning modules on IMCI including short videos available on the tablets. The REC itself evolved several times during the project period experiencing several software improvements on the tablet and the backend of the tool (data analysis) resulting in several consecutive versions of the REC.

The policy context

Free healthcare policy initiative

During the course of the project, a new policy emerged, which would potentially directly affect the utilisation of health services at health centre level. A free healthcare policy for children under 5 was nationally launched in April 2016 (Ministère 2016) (Gouvernement Burkinabe 2016). This decree was one step towards Universal Health Coverage (UHC) for which willingness of the Government had been officially formulated in September 2015 with a Law establishing a compulsory Universal Health Insurance (Conseil National de la Transition 2016). Following the implementation of this policy, the number of consultations in health centres increased. It is likely to have had a negative impact on the workload of health care staff in health centres and the systematic use of REC, which might have been the case in Toma district. The introduction of the new policy was followed by the start of the malaria season in June 2016. According to nurses interviewed, the period of adaptation to the new workload lasted around 7

months as soon as the malaria season ended and they had time to reorganise their services. In other words, the utilisation of REC was not deeply and durably impacted by the new policy.

Staff turnover

leDA was implemented in all primary health facilities including those located in rural remote areas, where healthcare workers usually do not want to spend more than a few years and where staff turnover was anecdotally said to be high. For example, in Titao district, it was reported that up to 95% of newly transferred staff were healthcare workers coming straight from nursing school with no primary experience. During interviews, district managers estimated that newly arrived staff worked during an average of three years in the district before asking to be transferred to another district. Staff turnover was also seen as a challenge for Tdh who worried about training staff and sustaining the utilisation of REC in each health centre.

In July 2017, all health care workers working in the four districts where leDA had been implemented, 31% of healthcare workers (62 out of 198) who were asked to use the REC had not benefited from the IMCI/REC training. This was exclusively explained by staff turnover: nurses who had been trained by the leDA project had been transferred to other districts and replaced by staff who had not received the initial IMCI/REC training. To triangulate the information, all 40 health centres were surveyed to understand staff turnover. It was found that 36% of nurses had been changed within the last 12 years, period of time corresponding to the first IMCI/REC training. District managers confirmed that the rate is constant every year. This suggests that every 12 months, around 40% of the nurses or midwives move to another facility (most of the time outside the district).

Innovation attributes

The leDA intervention and more specifically the technological innovation, the CDSS, provided to nurses on tablets was analysed in relation to Rogers' attributes: comparative advantage, compatibility, complexity, triability and observability.

Comparative advantage

In terms of comparative advantage, the REC was compared by healthcare workers to the previous situation where only paper-based version of the IMCI was available. We learned from the stepped wedge trial that IMCI paper-form was used for 68% (916/1,343) of the consultations in the control arm, while the REC was used in nearly all consultations (97%, 674/694) in the intervention arm. The healthcare workers highlighted the advantages of the REC, which is described as a tool covering several functions. The REC was well accepted by healthcare workers and became a routine tool in their practice to the point that healthcare workers contributed to the maintenance of the tool, regular synchronisation and did not hesitate sometimes to use their own money to cover internet costs.

The REC is primarily an eCDSS tool that guides healthcare workers in their clinical decisions and help them respect the recommended IMCI protocol. Step-by-step decisions the clinicians need to make

throughout the course of the consultation are guided by the software that forces the consultant to follow each step of the protocol in order to be able to complete the consultation. The district officers as well as the healthcare workers recognised that the tool is well designed and enables the healthcare workers to directly have access to the protocol without searching for the right information.

“If you directly register the child in the REC, it [the REC] provides the classification, the medicine you need to prescribe, even the dose. So no need anymore to search in the documents [i.e. IMCI paper protocol]. So to me, it is much easier like this: you ask questions, record the answer and this is finished. You get the treatment and the prescription. Huge advantage!” (healthcare worker).

The REC is described by many community interviewees as a living entity with its own autonomy and decision power. As a result, the “machine” brings its own independent opinion on the top of the healthcare worker’s opinion.

“It is the REC that helps quickly find the right products that are needed to treat my child when he is sick.” (Mother).

“The machine gives more information than the nurse”. (Father).

In a sense, the presence of the REC is reassuring for the community as it is a way to guarantee and triangulate the diagnosis provided by a nurse. To go further, it is as if the community had more trust in the REC viewed as generating a non-biased opinion:

“To me it is like a machine. It is a computer. This will diminish the errors. When I see some work done with a machine, I have no fear. I respect this work.” (Father).

A second advantage of the REC is the capacity to generate a **patient registry** and even the medical history of the child. Thanks to the patient history function, the healthcare worker can refine his/her consultation and ask further questions to the carer. Access to the medical history of the child is probably the most visible function from the perspective of the HCWs.

“When the child is here, you click here to see past treatments. You can see when he came and what reason. With the registry, it is very difficult. And we change registry all the time as soon as the pages are finished. But here, even one year later, you see everything.” (Healthcare worker).

Another important function of the REC is the **centralisation and sharing of data**. The patient registry is saved on the tablet, saved on a cloud and shared with district and national authorities.

“At the end of each week, data are sent to the district – very quickly – from the tablets without leaving the health centre. We can say that what we save is time.” (Townhall employee).

Compatibility

In terms of **compatibility**, we investigated the compatibility with the infrastructure, the use of IMCI, the health team and the relationship patient/clinician.

In terms of infrastructure, the REC did not create any specific challenge for the health centres, whatever their size. The introduction of the REC systematically generated amongst the health team an inventory of equipment missing or not functioning and the list of essential medicines. For example, in many health centres, after the IMCI training and the introduction of REC, we observed the creation of oral rehydration therapy (ORT) corners with plastic containers and oral rehydration solution (ORS).

“IMCI requires a consultation room dedicated to child consultations, which was possible in our health centre but we needed to move around furniture.” (Healthcare worker).

“At the start, we thought that the REC was asking for drugs that we do not have in stock. We then realised that these drugs were part of the essential list of medicines. We had to order them.” (Drug stock manager).

In terms of team organisation, health staff realised that the use of REC was easier with several health agents involved than a single personnel. For example, one agent, usually the outreach health agent, stayed in the waiting room and take basic measures (weight and size). When possible, two agents managed the consultation as a team. One person close to the child and a second person guiding the consultation with the tablet through each step of the IMCI protocol and recording data on the tablet. We observed several times the involvement of one member of the health centre management committee when staff were overstretched.

There were however situations when the use of REC was challenged by the population: when the agent was on his/her own and during the malaria season.

“If I take months such as September-October-November, when the waiting room is full of patients, people are vomiting, people are on the floor with fever, it is very challenging when staff is limited. The population would insult us if we are slow.” (healthcare worker).

In terms of patient/clinician relationship, the REC introduced a new way of interacting with patients. One concern at the start of the project was that the REC would increase the physical distance between the patient and the healthcare worker. In fact, we observed in several centres that one agent moved away from his/her desk to sit down next to the child in order to consult the child and ask questions to the carer. The healthcare workers noticed the satisfaction of the community in this new approach and felt a gain of trust from the community. When the REC was not functioning or out of battery, the community noticed it, asked for explanations and demanded the use of the REC during consultation time.

Complexity

Considering the limited level of computer literacy of their staff at primary health care level, complexity of REC was one of the main concerns the national policy makers had. It appears that the use of the tool is

perceived as being easy to understand after initial training. We have also observed that new comers in a health centre are immediately trained by their peers on how to conduct consultation with the REC and use the tablet. All healthcare workers trained on REC recognised the importance of coaching provided by Tdh following the training in order to understand some of the troubleshooting methods when the software or tablet had issues and verify they are doing the correct tasks.

The feedback loops established by Tdh to understand users' perspectives is also well valued as after each software version healthcare workers can see the improvements made compared to the previous in order to facilitate their work. The healthcare workers really understand that they are the key players in this project and that their voice and views are recorded and analysed to improve the usability of the tool.

The utilisation of REC becomes very complex when the system breakdowns. It happened that in the middle of the consultation, the software froze or the system shut down deleting all information registered during the consultation. We also observed that in some health centres, nurses were using the paper registry as they had serious issues with the battery of the tablet. The point here is to highlight that the introduction had become so much part of routine practice that its absence due to a breakdown was noticed by the healthcare workers and disrupted the organisation of consultations.

Testability

In terms of testability, we observed in a few health centres some resistance from heads of facilities. It was mainly due to the lack of self-confidence and literacy on using tablets and softwares. The coaching played a key role in accompanying individuals who had some reluctance in using REC and building their confidence. Coaches did not consider resistance as an exceptional event but rather assumed that resistance was the norm. As a result, any healthcare worker complaining about the innovation was not excluded from the intervention but on the contrary, their concerns were embraced by the coaches in order to build their skills and later their confidence.

Observability

In terms of observability (i.e. the possibility for the users to perceive visible benefits), interviewees listed quite a few aspects. First, the healthcare workers realised that the use of REC lead to a more rational prescription of medicine and reduced over-prescription, which is usually the result from community pressure. The presence of the tablet provided vis-à-vis the community arguments a rationale for the healthcare worker for not prescribing drugs when not necessary.

On the other hand, the healthcare worker through the use of REC had a better understanding of and adherence to the IMCI protocol as skipping steps were made unfeasible with REC. = As a result, healthcare workers felt more confident in their own classification and prescription.

"Without the REC, there are many questions we used to forget. But here, all the questions are listed and you cannot skip any of them. So to me, I think that we better manage patients. For example, when a child comes with a simple malaria, you can without the REC forget to identify anaemia." (Healthcare worker).

The REC was also seen as a dynamic tool, which evolved with the national policies through low cost uploads. During the course of the project in 2016, a revised version of the national IMCI protocol was introduced by MoH. The protocol was then supposed to be rolled out by the MoH, which required dissemination of the document and ideally refreshers for all health staff. With the REC, a revision of the protocol in the software and the upload of the revised protocol on each tablet were the only tasks necessary to a full roll out of the revised protocol.

From the perspective of the healthcare workers, nurses or nurse assistants, the REC also represented a tool supporting continuous development through the eLearning tools. Indeed, in 2017 were introduced online training modules with short demonstration videos.

“For example, in terms of respiratory infections, to check whether a child has a stridor, you can click on the REC to watch a short video with a specific case of stridor. The REC provides a few more extra details on what information we need to check to confirm a stridor. They are plenty of details provided.”
(Healthcare worker).

The quality of care approach promoted by MoH and Tdh went beyond the improvement of individual practice and behaviour change. A real support system was put in place engaging each level of the health system in the implementation and promotion of quality of care practices. This required the involvement of a wide range of actors ranging from national actors from all levels and sectors of the health system (different departments at MoH including family medicine, statistics and information) and international donors and United Nations agencies as well non-governmental organisations and civil society organisations and individuals (opinion leaders, religious leaders). Many of these actors were involved and engaged at each stage of the project to share views on the next steps of the implementation and scaling-up of leDA. The recognition of everybody’s voice created an atmosphere of mutual support and trust within health centres and between health centre staff and district health teams.

“The culture of performance and quality needs to start from the institutional level. We need to be able to support the institutional level, which means the national, district and health centre levels.” (Tdh).

The behaviour of health workers was also influenced by the new accountability system introduced de facto by the REC. Indeed, every healthcare worker needs to log in every time he uses the REC. The information officer at the district level could easily retrieve this information in case of problem. This was a significant change in the Burkinabe public service culture as for the first time this information could be used to identify malpractice (if needed).

The high level of commitment from a wide range of actors generated more legitimacy for the project and created a devolution of powers and responsibilities within the health system to monitor the quality of the services provided. Even most Heads of the health centres had a sense that it was their responsibility to monitor the quality of the consultations performed by their team.

“The person who leads the consultation has to provide his personal details, which helps identify who is in charge of the consultation, so we know the proportion of consultations performed by nurses, as they are the ones who supposed to do it. And when there are problems, we can identify which person has difficult conduct correct consultations.” (District Officer).

Analysis

CMO configurations

During the later phases of the analysis, we found that the adoption process can be grouped according to their key mechanism and this led to the description of parallel CMO configurations, each with their own outcome.

Table 2
the three CMO configurations related to leDA

Context	Mechanism	Outcome
C1. Availability of a support team to be responsive to healthcare staff questions.	M1. Promoting amongst healthcare workers “doing the right thing the right way” approaches	O1. Notions of quality in childhood illnesses routinised during consultations
C2. In health centres where the nurse is assisted by at least two other members (nurse assistants or outreach workers) and where management flexibility is allowed	M2. Clear distribution of roles before and during child consultations (including triage, weight and size measurements, consultation and counselling)	O2. Efficient organisation of the health team
C3. Strong consensus amongst stakeholders on the benefits of introducing REC	M3. Introducing at primary health care level the notion of individual accountability and responsibility and collective contribution to the wider system.	O3. Sustained use of REC as a routine practice with no interruption of the functioning of the tool

The first CMO can be summarised as: *with the support of a support team responsive to healthcare staff questions and needs (C1), promotion amongst healthcare workers of “doing the right thing the right way” approaches (M1) in order to routinise notions of quality in childhood illnesses during consultations (O1).*

The project is trying to influence practice of health care workers by moving away from “simply doing”. The awareness from MoH and Tdh that reducing the child mortality with the same level of resources from government can only be achieved by improving quality of care, which in the context of the project relates to correctness of classification and prescription. This also concerns the shift from output indicators to quality and outcome indicators, which implied an organisational culture change within MoH staff. In addition to the initial training, regular supervision was put in place to complement initial training with in service-supervision. This was accompanied by quality assurance sessions where staff in health centre were asked to find solutions as a team. There was also much attention for a clear role distribution within

a health centre. The notion of teamwork was emphasized by the project management team recognising the value and role of each member, whatever the title and background. In summary, both “hard” and “soft” management mechanisms were used to influence the organisational culture. The former included task distribution between health care staff by task - pre- (e.g. triage, child measurements), during (e.g. consultation and prescription), and post- (e.g. counselling) consultation tasks - and between clinical and administrative activities. The latter included initial IMCI/REC courses, peer pressure/support mechanisms and personnel development opportunities through eLearning modules. Availability of a support team to be responsive to healthcare staff questions and needs is an important context element and make possible the combination of all these management processes.

The second CMO configuration can be summarised as follows: *a health centre team where the nurse is assisted by at least two other members (nurse assistants or outreach workers) and management flexibility is permitted (C2) can be better organised and efficient (O2) when the roles of each member are well distributed before and during child consultations (M2).*

Key practices in this set included creating open discussions and dialog between all health team members on how the consultation should be organised considering the introduction of a new tool, the electronic tablet, and quality assurance sessions. In order to be more efficient, a triage was conducted in the waiting room by a nurse assistant or an outreach agent who identified the children in critical condition and take child measurement (e.g. size). This reinforced open relationships between health centre staff and contributed to solving practical problems and build solidarity between staff members. The quality assurance sessions were built around specific concrete issues experienced by the health centre team and elaborated realist solutions and action points, which achievement depended on how the members will work as a team. In turn, it stimulates the feeling of perceived organisational system and team mechanism. The leadership and management style introduced by Tdh is perceived by health centre staff to be effective and supportive.

The third CMO configuration can be formulated as *after creating strong consensus at all levels on the benefits of using REC (C3), sustaining the use of REC as routine practice (O3) requires introducing the notion of individual responsibility and accountability (M3).*

The members of the health centre, the primary users of the REC, had the feeling of belonging to a system that was wider than their health centre and contributing to a bigger enterprise than their own district. This was the result of early and ongoing engagement with a wide range of actors ranging from national and district authorities to opinion leaders at community level (Yukl 1999). REC users felt strong and wide consensus on the necessity of testing and using REC – a unique message sent by a multiplicity of key stakeholders influencing the environment of healthcare workers. The introduction of the notion of individual accountability in public services through personal login on the software also contributed to enhance a sense of individual responsibility and contribution to the wider system.

The new Medium Range Theory (MRT)

Our analysis identified four CMO configurations that indicate causal pathways between use of REC and sets of management practices, and we modified the MRT accordingly:

The adoption of a computer-based decision support tool by health staff at primary health care will be enhanced by having a leadership focusing on building wide consensus from surrounding stakeholders (local and national authorities) on the benefits of using such an innovation and having a wide of actors fully and truly engaged in the directions the project could take. This necessitates a system promoting flows of information between all levels of the health system where transparency of information is valued.

The introduction of such innovation needs to occur in an environment flexible enough to provide space to staff make decisions on the distribution of clearly-defined tasks within the team in order to better adapt their work to the new situation. On the other hand, the innovation, REC, needs to be flexible enough to take into account the constant changing policy environment and the emerging needs and requests from its users.

The REC is adopted when perceived by users and district managers as being encompassed within a broader quality improvement strategy where health staff is sensitised to the importance of quality and their capacity to address quality issues at their own level.

The introduction of the REC needs to be accompanied by a supportive atmosphere and environment (including community and policy makers support), which can be translated by peer support and district authorities support, and availability of support services responding to software or hardware issues. The supportive environment is based on reciprocity and acknowledges individual contributions to the wider system. Conditions for such environment to be promoted by a leadership that creates a decentralised decision space where initiatives are respected.

Discussion

This study offers interesting insights on how the introduction of one computer-based decision support tool combined with management support practices created new work practices.

Lessons for policy and practice

This project reinforces the point that in a successful diffusion of innovations (such as in the case of leDA), it is necessary to combine the introduction of technology with support and management mechanisms. It also shows that in management of healthcare workers, it is important to mix different management practices. It is also important to highlight that managers' attitude plays a great place in the success of the intervention: open dialog and respect are crucial dimensions. This is aligned with the findings from other studies.

Regarding the mechanisms, our findings relate to the analysis of Evans and Davis (2005) who situated the underlying mechanisms of high commitment management at the level of the internal social structure of the organisation. Such practices improve knowledge, practice and skills but also exert effects at the

level of relationships between team members but also with line managers (in this case, the district health managers). Shared strategic vision contributes to a stronger organisational culture (Granovetter 1973, Eisenberger, Hutchinson et al. 1986). Finally, a balanced management approach is costly, especially in management time (supervision, dialog, problem-solving sessions). It requires reasonable financial resources and a management capability to deal not only with administration but also with the less tangible issues of relationships, organisation culture and motivation of staff.

Methodological lessons

We used a realist evaluation approach as we see health facilities as primarily being social entities. Pawson argued that realist evaluation is well suited to investigate change in such social system (Pawson and Tilley 1997). However, appealing as it is, realist evaluation poses a number of challenges for the researcher.

The most critical issue is the attribution paradox. In complex systems, the behaviour of people is determined by many interlinked factors. Health professionals act under influence of their professional norms, social pressure, management interventions and their intrinsic motivation. Assessing the exact contribution of a set of management practices to overall performance is virtually impossible. What realist evaluation can do is to stimulate the researcher to describe a detailed picture of the causal web that includes the multiple determinants and to categorise these as intervention, underlying mechanism and context. In our case, we argue that open dialog, training and support services are essential, but we don't know which among these sets is the most important and in which setting.

The MRT is used in realist evaluation to clarify key findings. A MRT cannot cover all possible explanations of change. A realist evaluator does not pretend to provide the ultimate evidence that the intervention works. Rather, the MRT aims at enlightening the decision-maker, a process of utilisation of research that may be the most frequent in case of social research. In such cases, a pragmatic position should be taken whereby one tries to refine the MRT as much as practically possible with the explicit aim of providing options for improvement or scaling up rather than reaching a perfect understanding of the intervention as such.

Conclusion

The realistic evaluation complemented the results of the stepped wedge trial and provided further insights on what worked and in which circumstances. Introducing a digital clinical tool in rural primary health care facilities in Burkina Faso has demonstrated to be a great initiative well appreciated by patients' carers, authorities and healthcare staff. The introduction of the tool has requested investments in terms of supervision and coaching and harnessing team building and decision autonomy for decisions in each facility. This initiative really proves the interest of population and healthcare staff for tools consolidating clinical legitimacy. The use of realistic evaluation has showed being very valuable in documenting such real life issues and dynamics. Digital decision tools are now starting to being scaled up and such study design could serve as a foundation for the research community.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Review Boards of the Centre Muraz and the London School of Hygiene and Tropical Medicine.

Consent for publication

All participants to the study provided written consent.

Availability of data and materials

All transcripts and notes are available at Centre Muraz, Burkina Faso.

Competing interests

We declare no competing interest.

Funding

Funding was provided by Terre des hommes, Switzerland

Authors' contributions

Authors contribution: KB developed the methodology, analysed the data, drafted the paper, V-P S and ASS developed the tools, collected data and analysed the data, SS analysed the data and all authors contributed to the writing up of the paper.

Acknowledgements

The authors would like to thank the Ministry of Health in Burkina Faso, the Terre des hommes team for their continuous support and all the healthcare staff working in health centres in Burkina Faso for sharing their experience.

References

1. Aubert, B. A. and G. Hamel (2001). "Adoption of smart cards in the medical sector: the Canadian experience." Social Science & Medicine **53**: 879-894.
2. Evaluation in non-linear systems." Evaluation **9**(3): 265-284.
3. Black, R. E., S. S. Morris and J. Bryce (2003). "Where and why are 10 million children dying every year?" Lancet **361**(9376): 2226-2234.
4. Blanchet, K. (2013). "How to facilitate social contagion?" Int J Health Policy Manag **1**(3): 189-192.

5. Blanchet, K., J. J. Lewis, F. Pozo-Martin, A. Satouro, S. Somda, P. Ilboudo, S. Sarrassat and S. Cousens (2016). "A mixed methods protocol to evaluate the effect and cost-effectiveness of an Integrated electronic Diagnosis Approach (IeDA) for the management of childhood illnesses at primary health facilities in Burkina Faso." Implementation Science **11**(1): 1-9.
6. Bergman, M. M. (2008). Advances in mixed methods research: Theories and applications, Sage.
7. Bonell, C., A. Fletcher, M. Morton, T. Lorenc and L. Moore (2012). "Realist randomised controlled trials: a new approach to evaluating complex public health interventions." Soc Sci Med. **75**(12): 2299-2306.
8. Borgatti, S. P., M. G. Everett and P. Shirey (1990). "LS sets, lambda sets and other cohesive subsets." Social Networks **12**: 337-357.
9. Boss, L. P., M. J. Toole and R. Yip (1994). "Assessments of mortality, morbidity, and nutritional status in Somalia during the 1991-1992 famine. Recommendations for standardization of methods." JAMA **272**(5): 371-376.
10. Bowling, A. and S. Ebrahim (2005). Handbook of health research methods. Maidenhead, Open University Press.
11. Bryce, J., C. G. Victora and R. E. Black "The unfinished agenda in child survival." The Lancet **382**(9897): 1049-1059.
12. Chaudhary, N., P. Mohanty and M. Sharma (2005). "Integrated Management of Childhood Illness. Follow up of basic Health Workers." Indian Journal of Paediatrics **72**(9): 735-739.
13. Chen, H.-T. (1990). Theory-driven evaluations. Newbury Park, California, Sage Publications.
14. Conseil National de la Transition (2016). Loi numero 060-2015/CNT portant regime d'assurance maladie universelle au Burkina Faso. JO numero 07 du 18 Fevrier 2016.
15. Creswell, J. and V. Plano Clark (2007). Designing and conducting mixed methods research. Thousand Oaks, Sage Publications.
16. Deflaux, G. (2010). Registre Electronique de Consultations (REC) - Cahier des charges. Ouagadougou, Burkina Faso, Terre des hommes.
17. Deflaux, G., T. Agagliate, J.-E. Durand and P. Yamaogo (2014). Computerization of Medical Consultation for Children Under Five Years of Age in Rural Areas of Burkina Faso. Technologies for Sustainable Development. J.-C. Bolay et al. Switzerland, Springer.
18. Denis, J. L., Y. Hebert, A. Langley, D. Lozeau and L. H. Trottier (2002). "Explaining diffusion patterns for complex health care innovations." Health Care Management Review **27**: 60-73.
19. Denzin, N. and Y. Lincoln (1994). Handbook of qualitative research. Thousand Oak CA, Sage Publications.
20. Derenzi, B., T. Parikh, M. Mitchell, M. Chemba, D. Schellenberg, N. Lesh, C. Sims, W. Maokola, Y. Hamisi and G. Borriello (2008). "e-IMCI: Improving Pediatric Health Care in Low-Income Countries." CHI 2008.
21. Donaldson, S. (2007). program theory-driven evaluation science. Strategies and applications. New York, Lawrence Erlbaum Associates.

22. DSS/DGISS (2012). Enquete SARA. Ouagadougou, Burkina Faso, Ministere de la Sante.
23. Eisenberger, R., R. Hutchinson, S. Hutchinson and D. Sowa (1986). "Perceived organisational support." Journal of Applied Psychology **71**(3): 500-503.
24. Evans, W. and W. Davis (2005). "High-performance work systems and organisational performance: the mediating role of internal social structure." Journal of Management **31**(5): 758-775.
25. Fitzpatrick, R. and M. Boulton (1994). "Qualitative methods for assessing health care." Quality in Health **3**: 107-113.
26. Gouvernement Burkinabe. (2016). "Gratuité des soins pour les enfants de moins de cinq ans : Une réalité au Burkina Faso à partir du 02 avril 2016." Retrieved 15/08/2017, from <http://www.sig.bf/2016/04/gratuite-des-soins-pour-les-enfants-de-moins-de-cinq-ans-une-realite-au-burkina-faso-a-partir-du-02-avril-2016/>.
27. Granovetter, M. (1973). "The Strength of Weak Ties." American Journal of Sociology **76**: 1360-1380.
28. Green, J. (2006). Analysing qualitative data. Principles of social research. J. Green and J. Browne. Maidenhead, Open University Press.
29. Greenhalgh, T. (2008). "Role of routines in collaborative work in healthcare organisations." British Medical Journal **337**: 1269-1271.
30. Grilli, R. and J. Lomas (1994). "Evaluating the message: the relationship between compliance rate and the subject of a practice guideline." Medical Care **32**: 202-213.
31. Horwood, C., A. Voce, K. Vermaak, N. Rollins and S. Qazi (2009). "Experiences of training and implementation of the integrated management of childhood illness (IMCI) in South Africa: A qualitative evaluation of the IMCI case management training course." Social Science and Medicine **70**(2): 313-320.
32. Institute of Medicine (2001). Crossing the Quality Chasm: A New Health Care System for the 21st Century. Washington DC, National Academy Press.
33. Jones, G., R. W. Steketee, R. E. Black, Z. A. Bhutta, S. S. Morris and G. Bellagio Child Survival Study (2003). "How many child deaths can we prevent this year?" Lancet **362**(9377): 65-71.
34. Keen, J. and T. Packwood (2000). Using case studies in health services and policy research. Qualitative research in health care. C. Pope and N. Mays. London, BMJ books.
35. Kouanda, L. and A. Baguiya (2013). Evaluation de la qualite des soins prodigues aux enfants de moins de cinq (05) ans dans les formations sanitaires des regions du nord et du centre-nord du Burkina Faso. Burkina Faso, WHO, UNICEF, UNFPA.
36. Marchal, B., G. Westhorp, G. Wong, S. Van Belle, T. Greenhalgh, G. Kegels and R. Pawson (2013). "Realist RCTs of complex interventions - an oxymoron." Soc Sci Med **94**: 124-128.
37. Merton, R. K. (1968). Social theory and social structure. New York, The Free Press.
38. Ministere de la Sante (2011). Plan National de Developpement Sanitaire 2011-2020. Ouagadougou, Ministere de la Sante Burkina Faso.

39. Ministres, P. d. F. P. d. C. d. (2016). Decret 2016-311_PRES/PM/MS/MATDSI/MINEFID portant gratuite des soins au profit des femmes et des enfants de moins de cinq ans vivant au Burkina Faso. JO numero 22 du 02 Juin 2016. Ouagadougou, Burkina Faso.
40. Moore, G., S. Audrey, M. Barker, L. Bond, C. Bonell, W. Hardeman and et al. (2015). "Process evaluation of complex interventions: Medical Research Council guidance." BMJ **350**.
41. Morse, J. (2003). Principles of mixed methods and multimethod. In. Handbook of mixed methods in social and behavioral research. A. Tashakkori and C. Teddlie. Thousand Oaks, Sage Publications: 189-208.
42. Mugala, N., W. Mutale, P. Kalesha and E. Sinyinza (2010). "Barriers to implementation of the HIV guidelines in the IMCI algorithm among IMCI trained health workers in Zambia." BMC Paediatrics **10**(93).
43. Nguyen, D., K. Leung, L. McIntyre, W. Ghali and R. Sauve (2013). "Does Integrated Management of Childhood Illness (IMCI) Training Improve the Skills of Health Workers? A Systematic Review and Meta-Analysis." PLoS One **8**(6): e66030.
44. Oakley, A., V. Strange , C. Bonell, E. Allen and J. Stephenson (2006). "Process evaluation in randomised controlled trials of complex interventions." BMJ **332**(7538): 413-416.
45. Patton, M. (1999). "Enhancing the quality and credibility of qualitative analysis." Health Services Research **34**(5 Pt 2): 1189-1208.
46. Pawson, R. and N. Tilley (1997). Realistic evaluation. London, Sage Publications.
47. Plsek, P. E. and T. Greenhalgh (2001). "The challenge of complexity in health care." British Medical Journal **323**: 625-628.
48. Rakha, M., A.-N. Abdelmoneim, S. Farhoud and et al. (2013). "Does implementation of the IMCI strategy have an impact on child mortality? A retrospective analysis of routine data from Egypt." BMJ Open **3**(e001852).
49. Rihani, S. (2002). Complex systems theory and development practice. London, Zed Books.
50. Rogers, E. M. (1995). Diffusion of Innovations. New York, The Free Press.
51. Rowe, A., F. Onikpo, M. Lama and M. Deming (2010). "The rise and fall of supervision in a project designed to strengthen supervision of Integrated Management of Childhood Illness in Benin." Health Policy Plan **25**(2): 125 - 134.
52. Saunders, R., M. Evans and P. Joshi (2005). "Developing a process-evaluation plan for assessing health promotion program implementation: a how-to guide." Health Promot Pract. **6**(2): 134-147.
53. Schneider, B., S. Gunnarson and K. Niles-Jolly (2004). "Creating the climate culture of success." Organisational Dynamics **23**(1): 17-29.
54. Takada, S., B. Oudavong and C. Kuroiwa (2007). "The successes and challenges of the IMCI training course in Lao PDR." Southeast Asian Journal Trop Med Public Health **38**(1).
55. United Nations Inter-agency Group for Child Mortality Estimation (2015). Levels and trends in child mortality - Report 2015. New York.

56. Teddlie, C. and A. Tashakkori (2011). "Mixed methods research." The Sage handbook of qualitative research: 285.
57. Yameogo, P., B. Stoll, N. A. Zonon, T. Agagliate and G. Viala (2011). REC: Résultats d'utilisation d'un logiciel informatique pendant la consultation des enfants de moins de 5 ans selon la stratégie PCIME. Burkina Faso, Terre des hommes.
58. Yetton, P., R. Sharma and G. Southon (1999). "Successful IS innovation: the contingent contributions of innovation characteristics and implementation process." Journal of Information Technology **14**: 53-68.
59. Yin, R. (2003). Case study research: design and methods. London, Sage Publications.
60. Yukl, G. (1999). "An evaluation of conceptual weaknesses in transformational and charismatic leadership theories." Leadership Quarterly **10**(2): 285-305.