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Challenges and needs before implementing routine pulse oximetry within primary care for sick children in West Africa: baseline assessment within the AIRE project

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ABSTRACT

Background The Integrated Management of Childhood Illness (IMCI) guidelines are implemented within primary health centres (PHCs) in resource-limited settings. These symptom-based algorithms under-diagnose severe hypoxemia, which contributes to the under-five'mortality in sub-Saharan Africa. To improve the diagnosis and management of severe hypoxaemia, the Améliorer l'Identification des détresses Respiratoires chez l'Enfant (AIRE) project implemented the routine use of pulse oximetry (PO) within IMCI consultations in Burkina Faso, Guinea, Mali and Niger. We described the intervention sites and measured their capacity to offer IMCI care prior to project implementation.

Methods A cross-sectional quantitative survey was conducted in all the AIRE PHCs and their district hospitals (DHs) from March to July 2020.

Results Overall, 215 PHCs and 8 DHs were surveyed. Almost all the PHCs were public structures, mainly managed by nurses. At least one healthcare worker was IMCI trained in >99% of PHCs. At baseline, PO was available in only 2/215 (1%) PHCs and 4/8 (50%) DH. Median referral rate was estimated to 1.5% per PHC; 35/215 (16%) PHCs had functional ambulances for managing referrals to DHs, including two with mobile oxygen. IMCI consultations were free of fees in Burkina Faso and Niger, but charged for in Guinea and Mali (from US$0.5 to US$1). All the DHs had capacities to provide specialised paediatric care, although the use of PO was not systematic. Oxygen was available at all DHs except one. Parents of children requiring hospitalisation had to pay out of pocket costs ranging from US$1.7 to US$8.4 per day.

Conclusions This survey highlights the weak adoption of IMCI guidelines in these settings, the absence of PO's at PHC level and their low use at hospital level, as well as difficulties in managing severe cases, referral to hospital and accessing oxygen. It has guided the choice of the AIRE research PHCs and the upgrading of PHCs including IMCI training.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Globally, the weakness of the healthcare system to provide healthcare to sick children aged under five in sub-Saharan Africa had been demonstrated.
⇒ Few studies have provided indicators, such as human resources or accessibility challenges, but without real assessment.
⇒ Our site assessment was conducted before the Améliorer l'Identification des détresses Respiratoires chez l'Enfant (AIRE) project implementation in four West African countries. It assessed the capacity of the health facilities to provide healthcare to sick children aged under five using the Integrated Management of Childhood Illness (IMCI) guidelines or pulse oximetry (PO) before the routine introduction of PO within primary care.

INTRODUCTION

Children continue to face wide regional and income disparities in their chances of survival. Sub-Saharan Africa remains the region with the highest under-five mortality rates in the world—76 deaths per 1000 live births in 2017.[1] In 2019, 1 in 13 children in sub-Saharan Africa died before reaching their fifth birthday—a risk 15 times higher than that of children born in high-income countries. Among the leading causes of under five deaths worldwide in 2017, pneumonia was estimated to account for 24% of deaths,

WHAT THIS STUDY ADDS

⇒ We highlight major weaknesses of the healthcare system in the four countries where the AIRE project has been implemented.
⇒ Study countries have a shortage of skilled human resources in childhood care, a lack of paediatric medical equipment, including pulse oximetry at primary care, their poor use at hospital level and frequent shortages of essential medicines.
⇒ We report low use of IMCI within primary care, difficulties in organising hospital transfers for severely ill children, gaps in healthcare worker knowledge regarding the SpO_2 threshold indicating oxygen therapy, the unavailability of oxygen during hospital transfers and insufficient access to oxygen at hospital.
⇒ We identify difficulties in the implementation of the existing total or partial exemption payment policies that result in limited access to health services for sick children.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our work has guided the upgrading of sites before implementation of the AIRE project.
⇒ The findings may raise awareness among West African health authorities and communities of the major gaps in providing quality care to sick children under the age of five.
⇒ We highlight implementable solutions for improving IMCI services routinely at primary care, hospital referral and access to oxygen therapy for severely ill children.

followed by diarrhoea (15%) and malaria (9%).[1] In the West African region, neonatal conditions are more likely to be the leading cause of under five mortality (24%), followed by lower respiratory tract infections (16%), malaria (14.8%) and diarrhoea (13%).[2]

WHO and UNICEF have developed the Integrated Management of Childhood Illness (IMCI) strategy for children under five at primary health centres (PHCs) in low-resource capacity settings.[3–5] This symptom-based algorithm guides healthcare workers (HCWs) decisions which have improved their child health management. However, despite this tool, many children with serious illness remain unwell managed in sub-Saharan Africa, especially because of the lack of diagnosis capacities, timely hospital referral and adequate treatment.[6 7] For instance, the IMCI strategy is insufficient in addressing severe hypoxaemia (low level of oxygen in blood). The peripheral oxygen saturation (SpO_2) can be reliably measured by pulse oximeter (PO).[8] Severe hypoxaemia (SpO_2<90%) is a common sign of severity in children with both acute respiratory and non-respiratory illnesses.[9 10] It's significantly increasing their risk of death and requiring immediate oxygen. However, it remains under-diagnosed clinically when using only IMCI guidelines, and this gap would be addressed in using routine PO integrated into IMCI.[9 11] According to contexts, severe hypoxaemia prevalence varies between 2%[10] and 80%[9 11 12] in children under five with severe illnesses.

The AIRE (Améliorer l'Identification des détresses Respiratoires chez l'Enfant/Improving Identification of Respiratory Distress in Children) project aimed to improve the identification of severe hypoxemia and its appropriate care management by using routine PO into IMCI in children under five at PHC. It has been implemented since 2019 in four West African countries, Burkina Faso, Guinea, Mali and Niger, by a consortium of three non-governmental organisations, Alliance for International Medical Action (ALIMA), Solidarité Thérapeutique et Initiatives pour la Santé (Solthis), and Terre des hommes (Tdh) and the French Institute of Health and Medical Research (Inserm). From 2020 to 2022, the research component was implemented in collaboration with the Ministries of Health (MoH) to assess the routine PO introduction within IMCI for children under five in two health districts per country.[13] A better knowledge of the baseline context was thus needed in terms of organisation and functioning of each national healthcare system and health policy, place and functioning of PHCs and their relative hospitals referral to guide the implementation of the AIRE project. This baseline assessment was specifically aimed to: (1) Describe the health context of the intervention health districts, (2) Measure the capacity of health infrastructures to deliver IMCI services (training, medical equipment, drugs and consumables) and manage hospital referrals for children aged under five, (3) Describe their information system and (4) Guide the selection of the AIRE research PHCs to conduct the research component in each country.

METHODS

Study design

A descriptive cross-sectional baseline survey was conducted in all PHCs and their referral hospitals (table 1) selected in the four above countries to implement the AIRE project. We use the term district hospital (DH) for the referral hospitals in the district, even if they were not formally DHs.

Study context

The four West African countries were chosen because of their high severe disease-related under five mortality rates, the constraints of their healthcare system to provide adequate primary care to under five children with respiratory distress, and the pre-existing involvement of the NGO partners acting with the respective MoH in supporting healthcare system activities and capacities. This choice increased the feasibility and reduced the cost and risks, including the security perspective, of implementing the AIRE project. In each country, the project intervention took place in two health districts (figure 1). In Burkina Faso, Tdh led the implementation activities; in Guinea, it was ALIMA; in Mali, ALIMA was in charge in the district of Dioila and Tdh in the district of Markala; and in Niger, it was Solthis.

The four countries' healthcare systems are similarly organised in a pyramidal form at three levels: the health district at the bottom of the pyramid, the health region at the intermediate level and the central level at the

Table 1 Distribution by country and district of the 215 primary health centres, and eight district hospitals included in the baseline site assessment of the AIRE project, March 2020–July 2020

Country	Period of survey	Health district	NGO implementer	Number of PHCs surveyed	Number of DH surveyed
Burkina Faso	12 March 2020 to 29 May 2020	Dédougou	Terre des hommes	49	1
		Boromo	Terre des hommes	38	1
Guinea	16 March 2020 to 17 June 2020	Matoto	ALIMA	16	1
		Télimélé	ALIMA	14	1
Mali	16 March 2020 to 26 March 2020	Dioila	ALIMA	25	1
		Markala	Terre des hommes	19	1
Niger	16 March 2020 to July 2020	Niamey-IV	SOLTHIS	12	1
		Dosso	SOLTHIS	42	1
Total				215	8

ALIMA, Alliance for International Medical Action; DH, district hospital; PHCs, primary health centres.

top. Health facilities also integrate the same organisation with at the first level, the peripheral health structures with health boxes or dispensaries followed by the health posts or PHC, and the DH at the health district level, then the regional hospitals at the intermediate level which are health reference structures for the district level, and finally the national reference hospitals at the central level. The detailed description of the AIRE health districts selected in each country is presented in table 1 and online supplemental file 1).

The IMCI strategy established by the WHO[3–5] was implemented at PHC level in the four AIRE countries. It classifies sick children into three categories according to their illness severity (simple, moderate and severe), and to the age of the child to guide their appropriate care management. It has been slightly adapted at each

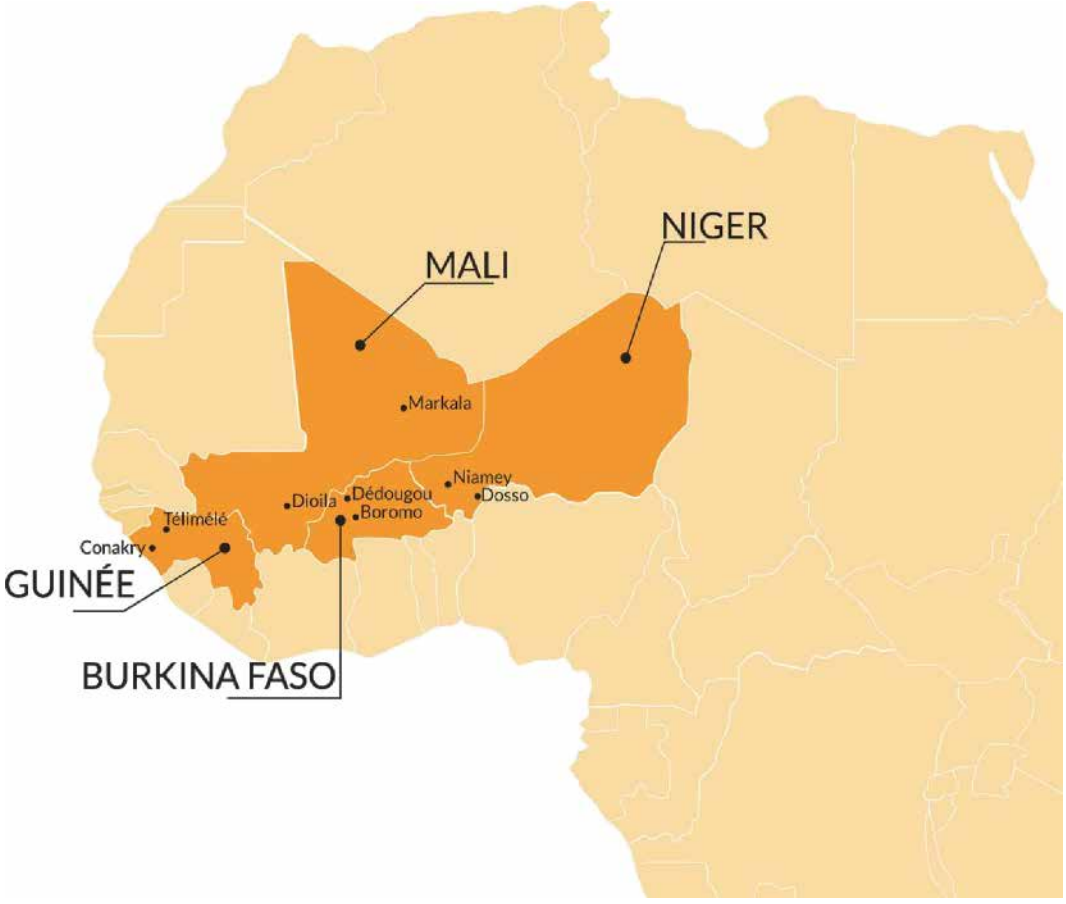

Figure 1 AIRE (Améliorer l'Identification des détresses Respiratoires chez l'Enfant) project implementation countries with the area of intervention (2020–2022). Conakry: Commune of Matoto—Niamey: Commune IV.

country level. In Burkina Faso and in the Markala health district in Mali, Tdh's Integrated e-Diagnostic Approach (IeDA)[14] has digitised the IMCI guidelines so HCWs can use it with a tablet. In the other health districts, HCWs used paper-based IMCI. The referral of seriously ill children identified at the PHC level was generally handled by the district healthcare system using either a PHC ambulance if available, or via a local organisation, but can also be handled using the regional or national ambulances.

Most West African countries have opted for total or partial free healthcare for children under five. Care payment exemption policy was full in Burkina Faso and Niger for the care of all children under five.[15 16] In Mali[17 18] and Guinea,[19] the payment exemption policy was partial and limited to the treatment of four diseases: malaria, tuberculosis, HIV and malnutrition. In each country, these payment exemption policies apply at PHC level, but do not clearly apply to hospital referrals.

Data collection

It should be emphasised that despite the COVID-19 pandemic and the restrictions imposed by countries, the NGO teams involved in the AIRE consortium were authorised to travel and therefore were able to collect the available data for each PHC. From March to July 2020, two standardised questionnaires were specifically conceived, one for the PHCs and another one for the DH (provided in online supplemental files 2 and 3), based on the WHO standards for improving quality of maternal, newborn, children and young adolescents care in health facilities.[20 21] Each questionnaire was completed by the research study team under NGOs' supervision in face-to-face interviews with each health facility manager. Data collected were: geographical location, accessibility to PHCs for the population and research teams (distance, road practicability, isolation during the rainy season and security), human resources, infrastructures, available medical and technical equipment and healthcare services for children under five, availability of PO and basic medicines, including antibiotics and oxygen (oxygen concentrators or bottled oxygen), cost of services, health data management tools, organisation of referrals. Data provided were also checked and completed using the available 2019 registers and activity reports from each healthcare facility. We extracted the number of children under five seeking curative consultations, number and % of children consulted using IMCI guidelines, and number and % referrals to hospital. Unfortunately, the quality of consultation registers was not sufficient at that time to provide specific data on the diagnostic outcomes after the IMCI classification. However, assuming that all the children referred would have been classified as severe cases according to IMCI, we used this number of referrals as a minimum approximation of the number of severe IMCI cases. Data were collected using an electronic questionnaire installed on tablets using Kobocollect software. This survey was conducted with the authorisation of the four MoHs in 2020.

Selection process of PHCs research sites

For logistical and financial constraints, the AIRE consortium decided to select only four PHCs per country (two per health district) to carry out the specific AIRE research component. This baseline survey guided the selection of these research sites dedicated to the collection of individual data, as planned in the research protocol.[13] The eligibility of PHCs was based on the following criteria:

- Having adopted the IMCI guidelines for the care of under five children.
- Never having introduced PO for the care of children.
- Being accessible to the members of the research team in terms of geographical and security barriers.
- Having access to the internet.
- Having a minimal organisation system for referral to hospital.
- Not having been selected to carry out specific COVID-19 interventions, as the SpO_2 threshold for referral to hospital was set at 94%, compared with 90% in the AIRE study.

Among the eligible PHCs, we selected at least one large and one medium/small PHC per health district on the basis of 2019 annual IMCI attendance to be representative of the different volumes of activity to study the implementation process of the AIRE intervention. Small PHCs were defined as ≤1000 IMCI consultations, medium between 1000 and 3000 consultations, and large centres >3000 consultations. The preselected PHCs were approved by the MoH authorities based on their best knowledge of the context and the real capacities of the proposed PHCs.

Finally, the 2020 COVID-19 pandemic prompted a specific intervention against COVID-19 that was implemented in the Matoto health district, Guinea. This intervention, using a SpO_2 threshold of 94%, different from the one chosen for the AIRE intervention, for the hospital referral of hypoxaemic patients, made it impossible to select the prospective research sites in Matoto. As a result, all the AIRE research sites for Guinea were selected in the Telimélé health district.

Data analysis

A narrative description of the infrastructure characteristics of the 215 PHCs and eight DHs was completed, then for the 16 research PHCs selected. Baseline health data outcomes extracted from the 2019 PHC reports were also described overall and for the 16 research PHCs to describe the rate of IMCI strategy use among all curative consultations of under five children (%), and the rate of referral among the IMCI consultations. As numbers of consultations using IMCI were not specifically available for the Telimélé health district in Guinea, we used the total number of curative consultations of under five children as the reference to estimate the % of referrals in this case. Quantitative data were analysed using medians and ranges. Proportions were used to describe categorical data. The data analysis was carried out with R software V.3.6.2.

Patient and public involvement

This study was conducted using programme data collected routinely. Patients were not involved in the analysis plan or result interpretation. Patients did not contribute to the writing or editing of this manuscript.

Ethics

The AIRE site assessment was carried out with the agreement of the participating sites under the formal authorisation of the four MoH involved in the project. Specific ethical committee agreement and specific individual consent were not required since it involved only programme data.

RESULTS

Characteristics of the 215 primary health centres of the AIRE project

Overall, 93% of the PHCs were public sites. They are all public in Burkina Faso, Télimélé (Guinea), Markala (Mali) and Dosso (Niger). However, 63% of the PHCs in Matoto (Guinea), 33% in Niamey-IV (Niger) and 4% in Dioila (Mali) were private or confessional. Overall, 83% were rural PHCs; the urban PHCs were located in Matoto and in Niamey-IV health district. The accessibility to the PHCs for study teams in terms of geographical barriers (impassable roads, hills or mountains, waterways, etc) or insecurity varied from 14% in Télimélé to 69% in Matoto. More than 95% of the PHCs were covered by a telephone network, and more than 80% of PHCs in each health district had internet access with the exception of the Boromo district in Burkina Faso (61% of PHCs). Overall, 76% of the AIRE PHCs were small to medium sized in terms of IMCI attendance, while the highest attendance was observed in the Niamey district with 8/12 (67%) large PHCs (online supplemental table).

PHCs health staff characteristics

Most of the PHCs (81%) were managed by nurses, varying from 58% to 100% according to health districts, except in the Matoto district where management was entrusted to the doctor. The seniority of these PHC managers varied from 0 to 5 years, except in Matoto where more than 80% had been in charge for more than 5 years. All but two PHCs (one in Dosso and one in Télimélé) have at least one HCW trained to IMCI guidelines (online supplemental table)

Medical equipment including PO

The medical equipment and registers needed to conduct IMCI consultations were often missing in the health facilities: 25% (3/12) of the PHCs in Niamey-IV had a paediatric scale. In Matoto, 50% (8/16) of the PHCs had a paediatric stadiometer and only 6% (1/16) had a stopwatch for respiratory rate measurement. Among the 215 PHCs, only 2 (1%) PHCs (Dédougou in Burkina Faso and Dioïla in Mali) had a PO. Oxygen concentrator was scarce, 3% (6/215) overall, with one in Burkina Faso (Dédougou), Guinea (Matoto), Mali (Dioïla) and three in Niger (one in Niamey-IV and two in Dosso) (online supplemental table).

Use of IMCI strategy

A difference was notified in the IMCI classification definitions between countries about chest indrawing, which was considered as a danger sign only in Guinea. Despite the IMCI strategy implementation in the AIRE countries, its adoption in practice was very heterogeneous at PHCs. In 2019, the use of IMCI consultation register was almost non-existent in Télimélé (Guinea) but generally in place in the other AIRE health districts. When available in the 2019 registers, the IMCI use among under five children attending curative consultations at the health district level ranged from 8% in Dosso (Niger) to 100% in Dioila (Mali); it was below 50% in Niger, above 63% in Mali and above 70% in Burkina Faso. The overall median rate of IMCI use per PHC reached 100% in Boromo (Burkina Faso), Matoto (Guinea), Diola (Mali) and Niamey-IV (Niger). In all countries, the IMCI classification outcomes were not properly filled in, and only the severe cases referred were notified (online supplemental table).

Organisation of hospital referral for severe cases

To refer children with serious illness, hospital referral forms were available in all PHCs, except in Matoto (31% of PHCs), Dioila (43% of PHCs) and Télimélé (16% of PHCs). Overall, no counter-referral system to inform the original PHC of the outcome of referred patients was in place, except in Burkina Faso. Functional ambulances were available in only 35 of the 215 PHCs (16%) covering all the health districts, but none in the Télimélé district. Only two (1%) PHCs (one in Dioïla and one in Matoto) could deliver oxygen during the transfer to hospital. Depending on the health district, 9% (21/215) of the PHCs have established community-based initiatives to organise referral of severe cases to the DH, but it was distributed only among the districts of Boromo, Matoto, Dioila and Niamey-IV. Finally, in terms of distances between PHCs and DH, only half of the PHCs in Matoto and 85% in Niamey-IV were <15 kms from the DH. In all the other districts, more than 86% of the PHCs are located at more than 15 kms from the DH, ranging from 36 kms in Markala (Mali) to 61 kms in Télimélé. The average distance between PHC and their DH varied widely among health districts from 4.5 kms (Niamey-IV) to 96.5 kms (Dosso). The median referral rate of severe cases based on the 2019 registers was very low everywhere, ranging from 0.7% in Boromo (Burkina Faso) to 2.5% in Dioila (Mali) (online supplemental table).

Cost of care

At the time of launching the AIRE project, IMCI consultations at the PHCs were free of charge in Burkina Faso and Niger, but charged in Guinea and Mali with declared prices varying from US$0.5 to US$1, respectively. The provision of free antibiotics was possible in the PHCs of

Burkina Faso and Niger, but not in the other countries (online supplemental table).

Characteristics of the 16 research PHCs selected for individual data collection

The 16 research PHCs selected with the MoH approval were public. Most of them were rural sites, with an average of three HCWs trained to perform IMCI consultations (range: 1–6) but no doctor. All had at least one consultation room where IMCI consultations could take place and had access to Internet. None of them has yet introduced the PO in practice. The equipment needed for IMCI consultations was available in most of the PHCs except in two sites in Guinea (Télimélé and Santou) and one site in Niger (Aéroport2) where paediatric scales, paediatric stadiometers, metric ribbons and stopwatches were missing; these sites had been upgraded before the AIRE research started. In terms of capacity to manage the referral of severe cases identified, 6 of the 16 PHCs (37.5%) had an ambulance: 0/4 in Guinea, 1/4 in Mali, 2/4 in Burkina Faso and 3/4 in Niger. But none of them was equipped to provide mobile oxygen for referral to the DH, which was 33.3 kms away on average (min=5 kms; max=75 kms) from PHCs. Télimélé' PHC was the exception because it was located close to the DH. All research sites were generally geographically accessible and safe for the population, except for Sibila (Markala, Mali) and Santou and Sinta sites (Télimélé, Guinea) due to impassable roads, especially in the rainy season, and the presence of rivers, hills and mountains. Otherwise, all research sites remain easily accessible for the project teams. Based on the 2019 registers, all the children under five who attended these PHCs were consulted using the IMCI guidelines, except in Télimélé, where this information was missing. Severely ill children referred to DH represented overall 1.2% of those attending care, ranging from 0.2% in Aéroport2 (Niger) to 6.6% in Kigoudou Koara (Niger) (table 2).

Characteristics of the AIRE DH

Geographical distribution, infrastructure in referral hospitals

Six of the eight hospitals are located in urban areas, except in Mali. All were able to deliver paediatric care to sick children. They have a general consultation and hospitalisation services, a nutritional recovery unit and a paediatric ward. However, paediatric emergencies did not exist in Télimélé (Guinea) and in Boromo (Burkina Faso); neonatology service did not exist in Guinea, nor at Markala and Boromo districts, respectively in Mali and Burkina Faso. All the AIRE DHs are supplied with electricity, either from the national grid for all formal hospitals, or with alternative solutions such as generators or solar panels.

Human resources at DH level

During the survey, the presence of several nurses (min=3; max=34 per DH) and at least one doctor (min=1; max=10 per DH) was noted. However, there were no paediatricians in the DH of Boromo (Burkina Faso), Télimélé (Guinea), Dioila and Markala (Mali). With regard to biomedical maintenance, all (7/8: 88%) but the Markala DH had a biomedical technician in place (table 3).

Availability of medical equipment, and PO use for paediatric care at DH level

The paediatric stadiometer (88%) and scale (75%) were tools generally available in the AIRE DH. No PO was used in the paediatric wards in Guinea and in Niger, but it was available in 100% of paediatric wards in Burkina Faso and Mali. The SpO_2 threshold of <90%, indicating oxygen therapy for severely sick children,[7] was unknown to 87.5% of the clinicians in DH. Only HCWs from the Dioila referral hospital in Mali knew the correct threshold (table 3).

Availability and delivery of oxygen and antibiotic prescription and cost of care at DH level

Regarding the availability of oxygen, the prefectural hospital of Télimélé in Guinea had neither oxygen nor a distribution system in place at the time of the survey. In the other seven DHs, several means of oxygen distribution were available and balanced each other out. In all AIRE DH, the most prescribed antibiotics were Ceftriaxone for 63% of DH, followed by Ampicillin for 25% of DH and Gentamicin for 12% of DH. The consultation for children under 5 years old was declared free of charge in the reference hospitals in Burkina Faso and Niger. In the other two countries, the declared prices of the consultation varied between US$0.5 and US$1.7. The daily prices of hospitalisation were US$0 in Niger, Markala in Mali and Dédougou in Burkina Faso, and varying from US$1.7 to US$8.4 in the other DHs (table 3).

DISCUSSION

This evaluation of AIRE health facilities, conducted in 2020 before the start of the AIRE intervention, provides a picture of the context in which the project was implemented, and raises awareness of the magnitude of the problem of childhood care in low-income settings.

Firstly, most PHCs were able to provide IMCI consultations, with at least one HCW trained per site in the four AIRE project countries. However, IMCI guidelines were often poorly applied when documented, varying from 8% to 100% depending on the PHC, and the reporting of IMCI results in routine registers in 2019 was non-existent at the PHC level. The PO was not introduced at the PHC level, even where an electronic IeDA-based IMCI support was in place.[14 22] PO was only present in 1% of the PHCs and in half of the paediatric services at DH. Other medical equipment specific to care of under five children was often not available in PHCs and DHs. Despite the 2014 WHO IMCI guidelines recommending if available, the use of PO[4 5 23] for all the children under five with respiratory signs at the PHC level, it is noted that none of the AIRE countries has actually made PO available at this decentralised level of the health pyramid. Similar findings were reported in PHCs in Uganda and

Table 2 Description of the 16 AIRE research primary health centres selected by health district and country, March–July 2020

Country	Burkina Faso				Guinea				Mali				Niger			
Health district	Boromo		Dédougou		Télimélé				Dioila		Markala		Dosso		Niamey-IV	
PHC name	Ouahabou	Oury	Fakena	Bissanderou	Telimele	Sinta	Santou	Sarekaly	Wacoro	Baoufoulala	Dougabougou	Sibila	Garankedey	Kigoudou Koara	Airport 2	Gamkalle
Public PHC	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Location	Rural	Rural	Rural	Rural	Urban	Rural	Rural	Rural	Rural	Rural	Rural	Rural	Rural	Rural	Urban	Urban
Accessibility for research teams	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
No previous use of the PO	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Internet access	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
No future research project planned	√	√	√	√	√	√	√	√	√	√	√	x	√	√	√	√
Health outcome data from the 2019 PHC reports																
Total# of curative consultations for children under five	4039	823	3099	2657	2255	2098	778	709	4262	1041	1561	1798	4153	2858	14 192	10 504
# of IMCI consultations for children under five	4039	823	3099	2657	NA	NA	NA	NA	4262	1041	1561	1798	4153	2858	14 192	10 504
% of children under five consultations using IMCI	100	100	100	100	NA	NA	NA	NA	100	100	100	100	100	100	100	100
# of hospital referrals for children	22	9	15	26	48	11	21	8	60	62	18	8	133	190	30	16
% of hospital referrals for children	0.5	1.1	0.5	1.0	2.1*	0.5*	2.7*	1.1*	1.4	6.0	1.2	0.4	3.2	6.6	0.2	0.2
Estimated size of the PHC in relation to the 2019 PHC attendance†	Large	Small	Large	Medium	Medium	Medium	Small	Small	Large	Medium	Medium	Medium	Large	Medium	Large	Large

*Compared with the number of curative consultations in children under five in the absence of IMCI data.
†Small (≤1000/year)—Medium (1000–3000/year)—Large (>3000/year), based on 2019 data from each health facility.
IMCI, Integrated Management of Childhood Illness; PHC, primary health centre; PO, pulse oximetry.

Table 3 Characteristics of the eight district hospitals involved in the AIRE project by health district and country, March–July 2020. (√=Yes, ☒=absence)

Characteristics of district hospitals	Burkina Faso		Guinea		Mali		Niger	
	CMA of Boromo	CHR Dédougou	Ignace Deen Hospital	Télimélé Prefectural Hospital	Dioila Hospital	Markala Hospital	CSME of Dosso	CHRN of Niamey-IV
Characteristics								
Urban area	√	√	√	√	☒	☒	√	√
Care services offer								
Department of Paediatrics	√	√	√	√	√	√	√	√
Department of Neonatology	☒	√	☒	☒	√	☒	√	√
Paediatric emergencies	☒	√	√	☒	√	√	√	√
General consultations	√	√	√	√	√	√	√	√
Hospitalisation	√	√	√	√	√	√	√	√
Nutritional Recovery and Education	√	√	√	√	√	√	√	√
Source of electrical energy supply								
National electricity grids	√	√	√	√	√	√	√	√
Generator set	√	☒	√	☒	√	√	√	√
Solar panels	☒	☒	√	☒	☒	☒	☒	☒
Characteristics of healthcare workers								
Paediatricians (#/DH)	0	4	5	0	0	0	4	5
General practitioners (#/DH)	1	4	5	2	5	3	0	1
Nurses (#/DH)	3	34	11	5	8	3	12	10
Midwives (#/DH)	0	9	0	7	3	7	1	5
Biomedical technician	√	√	√	√	√	☒	√	√
Staff training on oxygen therapy	☒	☒	√	☒	√	☒	√	☒
Availability and use of consultation facilities								
Functional paediatric scale	☒	√	☒	√	√	√	√	√
Availability of a paediatric stadiometer	√	√	☒	√	√	√	√	√
Use of PO in the paediatric ward	√	√	☒	☒	√	√	☒	☒
Knowledge of the SpO_2 threshold used for oxygenation of a child under 5 years of age (<90%)	☒	☒	☒	☒	√	☒	☒	☒
Oxygen supply and delivery								
Oxygen availability	√	√	√	☒	√	√	√	√
Means of oxygen distribution								
Oxygen in cylinders	√	√	☒	☒	☒	√	√	√
Wall circuit for the operating theatre	☒	☒	☒	☒	√	☒	☒	☒
#Functional oxygen concentrators (n)	1	4	1	0	2	0	5	7
Frequent breaks in oxygen	☒	√	√	√	☒	√	☒	☒
Cost of care								
Consultation fees for children under five in US$	0	0	0.5	1.1	1.7	0.9	0	0
Daily hospitalisation fees US$	1.7	0	6.3	8.4	2.6	0	0	0

DH, district hospital; PO, pulse oximetry.

Malawi.[24 25] In Nigeria, Graham's assessment in 2021 revealed that none of the 28 PHCs studied had a PO, and that all three hospitals had one, but it was functional in only one of them.[24] This situation is widespread in West Africa, but also in East Africa and Asia,[26] which raises other problems such as the adequate supply of medical equipment, including PO, but also the insufficient level of IMCI awareness and training of HCWs.[24 25] Evaluation of the IeDA intervention using electronic IMCI support resulted in significantly improved HCWs' adherence to IMCI clinical assessment tasks, leading to an overall increase in correct classifications.[14] Although this is not

supported by our baseline data, we will take into account the type of IMCI support (electronic vs paper) in future analysis of the AIRE results.

Secondly, our findings show the weakness of the AIRE countries' health system in providing care to children under five with severe disease. The lack of qualified HCWs observed in our survey partially explains the low quality of health services, already described elsewhere.[27–29] Based on referral estimates from the 16 research PHCs, only 1.2% of children under five attending PHCs were referred to the hospital in 2019, which probably only represents those actually transferred rather than those eligible for referral according to IMCI classification. In fact, this is a significantly lower proportion than the expected 15% estimated by Floyd.[9] In reality, our results highlight the lack of West African health policies oriented towards oxygen administration at the PHC level where hypoxaemia was under-diagnosed if no PO is used.[30–33] Our survey focused on the challenges in referring severely ill children to the hospital, and specifically for those hypoxaemic, with no functional ambulance available and the inaccessibility of mobile oxygen during transfer to the DH. Indeed, we noted the absence of an oxygen delivery system at the PHC level and in ambulance, only 3% and 1%, respectively, were able to administer oxygen therapy, and also the lack of knowledge by the HCWs of the threshold indicating oxygen therapy. Even though oxygen was available in almost all AIRE DH, the oxygen insecurity with frequent breaks was noted, as observed in Kenya,[34] as well as the need for support and training for HCWs in administering oxygen therapy.[35] In Nigeria, H. Graham reported that 43% of PHCs (12/28) had an oxygen source.[24] Oxygen distribution circuits are not available at the PHC level but rather at the hospital level. The question of hospital transfers of children with serious illnesses remains unresolved in the four countries with few functional ambulances and few community initiatives. Indeed, our survey reveals the absence of an organised referral system in most PHCs. Very few PHCs (10%) had a community structure involved in organising the referral of severe cases. We noted that despite several initiatives, such as the implementation of the additional cent in Niger[36] or community-based organisations in Mali or Burkina Faso,[37] the field reality is different. Hospital transfers are unaffordable for most families and are not effectively functional.

Finally, concerning the costs of healthcare policies in Niger and Burkina Faso, our baseline assessment found that parents should not have to pay for consultations at the PHC or at the DH in general (except in Boromo DH). In Mali and Guinea, families were expected to pay fees for consultation ranging from US$0.5 to US$1.0 at the PHC level to US$1.7 at the DH, and daily hospital charges ranged from US$2.6 to US$8.4. It should be noted that despite the free care policies for children under five, families are sometimes obliged to pay for certain drugs, such as antibiotics outside the PHCs, due to frequent drug shortages. Some authors have also noted other irregularities and effects in the implementation of these free healthcare policies,[15 16] such as parallel undeclared expenses or corrupt practices reported in a study conducted in Anglophone West Africa.[38] The medium-term consequences are an increase in health costs for families.[37 39]

We acknowledge several limitations in this study. First, the health districts were deliberately chosen according to the area of intervention of the NGOs of the AIRE consortium; PHCs were therefore not entirely representative of all PHCs in each country, limiting the generalisability of the results. They should be interpreted as those of a pilot study. Another weakness is that the assessment of healthcare facilities was not based on a standard approach such as SARA[40] for logistical and financial reasons, the objective being to focus specifically on IMCI implementation and PO availability. Third, the survey was conducted just after the closure of the borders due to the COVID-19 pandemic that has occurred in 2020, resulting in the organisation of remote training sessions for the research data collectors supervised by NGOs in each country. Although these data collectors were able to visit each PHC for face-to-face interviews, given that the NGOs had permission to carry out their activities, we cannot exclude between-country differences in conducting data collection. In addition, self-reported data reported by PHC managers can be subject to information biases. Nevertheless, the health data outcomes reported were checked against retrospective sources available based on the 2019 reports and registers, but their quality varied notably between PHCs and was sometimes very incomplete (particularly in Guinea), explaining some inconsistencies. Finally, the severe IMCI case rates that are based on the referral rates reported were likely to have been underestimated. Overall, it can be assumed that health outcome data were worsened by the COVID-19 pandemic[41] with the possible exception of access to oxygen and other health equipment to manage health emergencies at hospital level, which has improved thanks to numerous initiatives such as ACT-A during the pandemic.[42] Overall, these limitations do not preclude the interpretation of our results providing an overall picture of the health system capacity to provide adequate primary care to severely ill children under five at each country level before the implementation of AIRE operational activities.

The information provided highlights major gaps in childhood care in this West African context, needing to be addressed with the involvement of HCWs, health authorities and communities. Practical solutions which can be implemented immediately without major resources could include, for example, setting up systems for maintaining and upgrading health facilities with regard to basic equipment for carrying out IMCI consultations, introducing IMCI registers reporting severe cases and the SpO_2 value using PO, reinforcing training supervision to motivate HCWs and maintain their high levels of skills at the primary care level.[25 43 44] Then, pooling the use of ambulances from other PHCs, setting up a community health insurance/tontine to provide financial support for all severe cases that need to be referred to hospital. With the aim to improve

earlier and timely access to oxygen, it would make sense to further invest in oxygen delivery at PHCs if hypoxemic children are better diagnosed using PO. However, such interventions will need to be further assessed.

CONCLUSION

This survey conducted at the start of the COVID-19 pandemic, before the AIRE project implementation, highlights the unavailability of POs at the PHC level and a significant shortage of POs at hospital level. It also reveals the lack of qualified human resources, the lack of registers to document routinely the IMCI health outcome indicators, the low rate of severe cases transferred to referral hospitals, difficulties in transferring patients to hospital and accessing oxygen. There are also economic and social inequities in access to care for children under five which need to be taken into account.[29] This baseline assessment has guided the upgrading of health infrastructure capacity (health medical equipment, medicines, oxygen supply, …). Our study provides useful data for a better understanding of the context and identification of the challenges to address before the AIRE intervention. Finally, it suggests implementable solutions for strengthening IMCI services routinely at primary care, hospital referral and access to oxygen therapy for severely ill children to improve their survival.

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