

# BMJ Open Quality E-IMNCI: a novel clinical diagnostic support system approach to strengthen effectiveness and quality of IMNCI implementation in India

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## ABSTRACT

Integrated management of childhood illness is a globally proven primary care strategy to improve child survival and is being implemented worldwide in countries with high burden of child mortality. Its implementation as Integrated Management of Newborn and Childhood Illness (IMNCI) in India has been challenging.

The primary objective of the present work was to assess the feasibility, acceptability and use of an adapted Integrated E Diagnostic Approach (leDA) that provides e-Learning and improved clinical practices of the primary level health service provider auxiliary nurse midwives (ANMs) to deliver IMNCI services. This India-specific approach was contextualised to the Indian IMNCI programme based on 7 years of leDA implementation learning from West Africa.

The Integrated Management of Neonatal and Childhood Illness pilot was implemented across 80 front-line workers, 70 ANMs and 10 medical officers) in 55 facilities of 3 blocks of Ranchi district, Jharkhand. This report evaluated the feasibility of its use by ANMs only. Based on the results, it can be concluded that it is possible to implement the newly developed application. A total of 2500 cases were managed by ANMs using the application till May 2020. All ANMs used it to provide treatment to the children. 63% of ANMs used it to provide medications, 83% for counselling and 71% for follow-up as per the recommendations. The app is highly acceptable to ANMs for use as a clinical case management tool for childhood illness. There were some improvements in case management in both the age group (0–59 days and 2–12 months) of children. 78% of caregivers responded with their desire to revisit the health facility in future, highlighting the contribution of an e-tool in improving the perception of the caregiver.

## INTRODUCTION

Integrated management of childhood illness (IMCI) is a globally proven, primary care strategy to improve child survival and is being implemented worldwide in countries with a high burden of child mortality.<sup>1,2</sup> India adopted and implemented IMCI, which addresses a child's overall

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Integrated Management of Newborn and Childhood Illness (IMNCI) is a cost-effective and efficient strategy to improve child survival and is tried and tested across various parts of the globe. Terre des hommes initiated Integrated E Diagnostic Approach (leDA) in West Africa (Burkina Faso) in 2014 through an android based digital job aid, with the goal of reducing child mortality by enabling a better quality of health services through mobile health tools, quality improvement processes and a data management strategy. leDA helps the primary healthcare workers improve their level of adherence to the Integrated Management of Childhood Illness clinical guideline. E-platforms have been advocated by WHO based on the country's assessments for accelerating IMNCI implementation.

## WHAT THIS STUDY ADDS

⇒ This is the first study from India on use of e-platform for improving the quality of IMNCI implementation. The study demonstrates the major strength of Integrated Management of Neonatal and Childhood Illness (E-IMNCI) in making use of evidence-based clinical management decisions to reduce preventable deaths due to childhood illness. Also, the capacity building of front-line workers focused on communication, counselling, management and tracking of illness will increase the effectiveness of care and simultaneously reduce cost.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The E-IMNCI tool using the country-based approach can be used for capacity building and improvement in quality-of-service delivery. This approach gives the human face to the digital application, thus is more conducive to sustainability and taking to scale. The real time data submission and analysis could be used for policy decision-making and programme purpose.

health with interventions in homes, communities and facilities for children under 5.<sup>3</sup> With the adaptation of the change in name

from IMCI to Integrated Management of Neonatal and Childhood Illness (IMNCI), the duration of training was reduced from 11 days to 8 days, and 50% of the period of training (4 days) was dedicated to newborns. IMNCI formed the central strategy of the Reproductive Child Health (RCH) II programme. By June 2010, it had been implemented in 223 of India's 640 districts, and more than 200 000 workers had been trained.<sup>4</sup> IMNCI strategy includes capacity building of health workers, health system strengthening and improving community and family practices, all of which need to be implemented in a coordinated manner.<sup>5,6</sup> After 2010, there are no other implementation reports available from the country.

A rapid assessment of IMNCI undertaken in 12 districts of 7 states showed that home visits under IMNCI reached only 64% of births and the newborns who remained unreached were likely to be the ones who were the most vulnerable.<sup>7</sup> Skills of assessing and classifying illnesses based on guidelines were conflicting in different studies conducted in Haryana, Gujarat, West Bengal and Maharashtra. The implementation of IMNCI for community centred case management is constrained in the country with a poor capacity of workers, long duration of the training, the inadequacy of trainers/supervisors and absence of refresher training in addition to financial and human resources constraints.<sup>8–12</sup>

With the recent advances and expansion of access to new technologies, the use of Electronic Clinical Decision Algorithm in low-income countries has become feasible and holds the potential to overcome these challenges and improve the management of childhood illnesses.<sup>13</sup>

In a pilot study conducted in Tanzania, the use of an electronic version of IMCI (E-IMCI) on Personal Digital Assistants has shown to increase adherence to IMCI guidelines, reduce errors and improve the quality of care in the same consultation time as routine practice.<sup>14</sup> In another study, mobile technologies have improved communication with the caretaker and also improved impact of counselling.<sup>15</sup>

An evaluation of the large-scale implementation of the electronic Integrated E Diagnostic Approach (IeDA) at the primary care level also concluded that the use of e-tool was widely accepted and perceived as a powerful tool guiding daily practice.<sup>13</sup>

The primary objective of the present work was to develop and assess the feasibility and acceptability of Integrated Management of Neonatal and Childhood Illness (E-IMNCI) application, compliance with case management algorithms, data management and experiences of the community. The work was carried out under the leadership of the Government of Jharkhand with Terre des hommes and IPE Global's collaboration.

## SOLUTION

E-IMNCI was developed as an adapted approach of IeDA, integrating capacity building that provides e-Learning and improved clinical practices for the primary level health service providers (ANMs and MOs). The E-IMNCI

auxiliary nurse midwife application was installed in the tablets provided to the ANMs by the Jharkhand state government as a part of the existing health programme. The application of MO is also an android-based application. Two solutions were developed, but this study shares the findings from the tablet-based solution used with ANMs, as the number of medical officers (MOs) were small.

The application was developed according to the digital development principles and went through approval of its protocol by the State NHM—Child Health Technical Division to ensure complete alignment with the national IMNCI case management algorithms.

## METHODS

The E-IMNCI pilot was implemented across 80 front-line workers, 70 ANMs and 10 MOs in 55 facilities in 3 blocks (Ratu, Angara and Namkum) of Ranchi district in Jharkhand.

A short IMNCI training (4 days) was imparted to 60 ANMs and 5 MOs from 52 facilities. The training also included hands-on skills building for using the application. The rest of the health workers were not able to be trained due to their deputation during the pandemic, however, they were followed up later.

A baseline assessment using a mixed-method approach with both quantitative and qualitative data was undertaken with 40 ANMs in October 2020. The baseline assessment included structured interviews and focused group discussions with 40 ANMs and 40 mothers/caregivers of under 5 children. ANMs were assessed for their knowledge and perceptions about IMNCI guidelines. The assessment also included observation of the ANMs handling real cases and simulated ones. IMNCI trained Health workers from 26 facilities were contacted, whereas availability of medicine and equipment were mapped from all the facilities during the baseline. The assessors included IMNCI trained supervisors proficient in using the e-tool.

An 'E-IMNCI' application was developed and provided to ANMs and MOs in January 2021. The 'E-IMNCI' application has learning resources such as chart books and video clips, decision-making tools for on-the-job assistance and patient records. E-IMNCI application also has a logistic management tool that allows ANMs to check stock availability and alerts when it falls below a critical level. The decision support tool was customised to the country's IMNCI guidelines. It helps in the registration, assessment, classification, identification of treatment, follow-up and referral of patients with two separate protocols, one for ANMs and one for MOs, with features to measure individual performance. The application automatically creates and maintains a patient file for each child managed at the health centre, including the history of all consultations made and treatments prescribed. The data collection mechanism has a simplified user interface and intuitive application workflow, and a system for generating reports for supervisors and decision-makers. The

data generated were collected on a CommCare platform and made available to decision-makers in the form of customised dashboards and can be linked to any existing data collection portal of the country.

A postimplementation assessment was conducted in 38 facilities after 4 months in May 2021 using a similar approach to the baseline. In this assessment, 52 ANMs and 51 caregivers participated and included 49 case observations to record any changes in knowledge and practices. The assessors ensured that no child leaves the facility without correct case management. Qualitative in-depth interviews were conducted with government health officials, postimplementation only. These interviews with key officials helped to understand the responsiveness of the initiative to system strengthening, suggestions and ways to scale up. Quality and accuracy were ensured by recording the interviews between the assessor and a few randomly identified respondents using a computer-assisted personal interviews device. Quality control telephonic checks were performed with 15% of interviewed respondents. SPSS 25.0 was used for data analysis for the quantitative surveys. In addition, for two segments, that is, health workers and caregivers, a t-test (one tailed) was carried out to understand whether the result of the postimplementation was significantly different than the baseline. For the observation of case management by the health workers, Mann-Whitney non-parametric test was conducted to check the significance of baseline and postimplementation due to the relatively small sample size.

### Patient and public involvement

A total of 2500 cases were managed by ANMs using the application till May 2022 and the application is still in use. Mothers of children managed were interviewed both at baseline and after 4 months to assess their perception on the quality of services. Qualitative interviews with mothers/care givers helped to understand the experiences and level of satisfaction of mothers and care givers of under 5 children.

## RESULTS

### Participant characteristics

All the ANMs were posted in health facilities, 95% at health subcentres and the remainder at primary health

centres. They were 20–59 years in age, with 80% in the 31–50 years age group. All the ANMs had undergone professional ANM courses with 75% having work experience of 10–15 years and 15% of ANMs with more than 30 years' experience. They all had the state provided tablets but had not used them. All of them were comfortable using smartphones and were using their phones to enter data for family planning programmes.

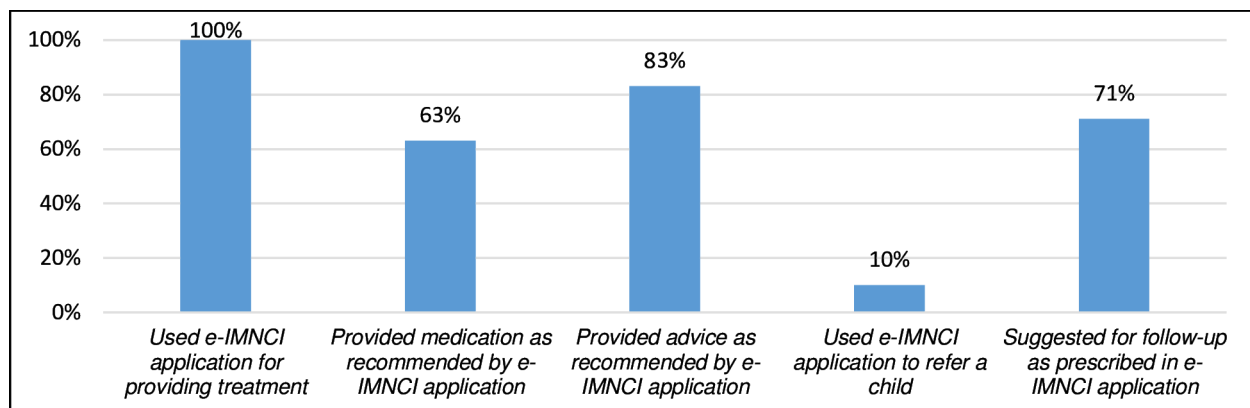
The E-IMNCI application was well accepted, and all the ANMs (100%) used it to provide treatment to the children. The application was also utilised by ANMs to provide medications, counselling and follow-up as per the recommendation (63%, 83% and 71%, respectively). However, only 10% suggested referrals recommended by the app (figure 1).

### Knowledge and case management practices

Knowledge of ANMs on identifying clinical signs and symptoms improved. Seventy-five per cent ANMs correctly identified the order of E-IMNCI clinical case management, and 70% and 90% ANMs could recall assessment steps correctly for the infant and child in IMNCI case management (baseline vs postimplementation). 87.5% of all respondents (ANMs and MOs) agreed to the essentiality of referring to the IMNCI protocol postimplementation against 32% at baseline. At postimplementation, 100% ANMs checked records of the previous visit and counselled patients for a follow-up visit.

The postimplementation assessment showed that the assessment of signs such as feeding difficulty, convulsions, counting respiratory rate, umbilical sepsis, axillary temperature recording, signs of dehydration improved in the age group of 0–59 days. Skills for assessing chest indrawing and thrush needed further strengthening. Assessment steps for checking breastfeeding attachment, correct suckling and oral thrush showed a decline. These results are shown in table 1.

There was marked improvement in assessing general danger signs in the age group of 2–12 months. However, only 26% of ANMs assessed at least three danger signs for the age group 2 months to 5 years. The use of pulse oximeter (83%), assessing signs of dehydration (100%),



**Figure 1** Usage of E-IMNCI app for case management. E-IMNCI, Integrated Management of Neonatal and Childhood Illness.

**Table 1** Assessment of young infant (children aged less than 2 months) by ANMs

Particulars	Baseline (N=11)		Postimplementation (N=6)		P value (one tailed t-test)
	n	%	N	%	
Asked about infant have any difficulty in feeding	7	63.6	6	100	0.051
Asked for convulsions	0	0	6	100	
Checked for severe chest indrawing	2	18.2	1	17	0.676
Respiratory Rate counting for 1 min	2	18.2	6	100	0.000
Checked for umbilicus red or draining pus	1	9.1	6	100	0.000
Checked for axillary temperature	0	0	3	50	
Checked for skin pustules	1	9.1	6	100	0.000
Asked about presence of diarrhoea	4	36.4	6	100	0.004
Asked if the infant is breastfed	9	81.8	6	100	0.147
Asked, if the infant usually receive any other foods or drinks	1	9.1	0	0	
Determined weight of infant	1	9.1	6	100	0.000
Checked for infant's attachment during breast feeding	3	27.3	0	0	
Checked for infant's suckling effectively	3	27.3	0	0	
Looked for oral thrush	3	27.3	0	0	
Checked for did mother have any pain while feeding	1	9.1	0	0	
	N=4		N=6		
Checked for infant movement	0	0	6	100	
Checked for sunken eyes	0	0	6	100	
Skin pinch test conducted	0	0	6	100	

ANMs, auxiliary nurse midwives.

assessment for the presence of stiff neck (59%) in cases with fever in the age group 2 months to 5 years have also improved. These results are shown in [table 2](#).

The postimplementation assessment showed that using E-IMNCI application logistic management tool by the ANM's led to improvement in availability of the essential medicines and equipment required for delivering good quality care, at all the health facilities ([table 3](#)).

### Experience of healthcare workers (ANMs) and caregivers

ANMs interviewed at postimplementation were very satisfied with the content, curriculum, method and duration of the E-IMNCI training. The ANMs mentioned various small videos and photos embedded in the app to be informative and easy to follow. 89.6% of them rated the interactive learning sessions as very good.

Regular submission of data on the application was seen, with 91% of the ANMs reporting the application based IMNCI format easier than the paper based. The average time to fill in an online application was 12 min during the end line assessment against the 24 min it took to fill when using paper-based formats during the baseline.

Ninety-one per cent of ANMs found the application-based case management format easier than the paper-based one. Fifty-eight per cent of ANMs reported that the use of the app had resolved the challenges they used to face like difficulty in understanding the IMNCI protocol, remembering the clinical steps, etc. One hundred per cent of the trained healthcare workers (HCW) could register a case using the E-IMNCI application and knew how to enter the vital signs and symptom of ailment as well as decide on the course of treatment using the application. Ninety-six per cent of HCWs knew how to navigate the application (moving back and forth, changing language, etc) and believed the IMNCI process had been made very interactive with the caregivers of the patient and user friendly with the help of E-IMNCI ([figure 2](#)).

There was a substantial improvement in the satisfaction level of mothers on staff behaviour and receiving medication (45% against 15% during the baseline). Seventy-eight per cent of caregivers responded with their desire to visit the health facility again in the future highlighting the contribution of application in improving the perception of caregivers.

**Table 2** Assessment of children (aged 2–59 months) by ANMs

Assessment among children aged 2 months to 5 years by ANMs					
General danger signs	Baseline (N=26)	%	Postimplementation (N=43)	%	P value one tailed
Asked the mothers whether the child can drink or breastfeed	0	0	33	77	
Asked the mother whether the child vomited everything	0	0	22	51	
Ask: Has the child had convulsions	0	0	17	40	
Assessment of child with cough/difficulty breathing	N=15		N=18		
Asked the mother whether the child has 'cough' or difficulty breathing	15	57.7	18	42	0.896
Asked the duration of cough	1	4	11	61	0.001
Correct assessment of respiratory rate	10	66	18	100	0.065
Correct assessment of the chest indrawing done	8	30.8	16	89	0.417
Checked SPO2 (Oxygen Saturation)	0	0	15	83	
Assessment of sick child	Baseline (N=26)		Post-Implementation (N=43)		
	n	%	n	%	
Asked if the child has diarrhoea	9	34.6	21	49	0.255
Asked about history of fever in child	9	34.6	32	74	0.000
Looked for visible severe wasting	7	26.9	0	0	
Check for oedema on both feet	1	3.9	12	28	0.006
Check for the child's immunisation status	18	69.2	34	79	0.183
Check for palmar pallor	0	0	22	51	
Assessment of the child with diarrhoea	N=9		N=21		
Asked diarrhoea duration	0	0	12	57	
Looked for sunken eyes	0	0	21	100	
Assessed skin turgor	0	0	21	100	
Checked (lethargic or unconscious restless or irritable)	0	0	13	62	
Assessment of child with a history of fever	N=9		N=32		
Assessed the child's fever even if the child does not have a temperature of 37.5°C or above or does not feel hot now	1	11.1	29	91	0.000
Asking fever 'for how long'	0	0	26	90	
Checked for stiff neck	0	0	19	59	
If fever is present for more than 7 days—correctly asked	–	–	23	88	
Assessment of child's nutrition status	N=17		N=42		
Taken mid-upper arm circumference (MUAC) for children above 6 months	0	0	26	62	

ANMs, auxiliary nurse midwives.

### DISCUSSION: WHAT DOES IT MEAN?

The acceptability of the tool and its usage in case management could be experienced in this study. The feedback from ANM reveals that the application-based IMNCI is very acceptable among ANM in India. The results show that the application interface is improving the adherence of ANM to IMNCI protocol, by providing them stepwise guidance. While 2500 cases have been managed till May 2022, further learnings will be derived later in the implementation with a subsequent assessment.

The training included steps of management using the features of the application. The method does not allow us to know the impact of training and intervention separately. The number of cases observed was limited at the facility, due to low footfall at the facility during the pandemic and the survey was conducted during the COVID-19 pandemic. In India, front-line health workers (FLWs), serve as an essential link to the public health system by bringing services to people's doorsteps. ANM is a primary healthcare provider to a local population

**Table 3** Impact on availability of medicine and equipment at facilities

	Baseline (%) (N=52)	Postimplementation (%) (N=38)
Amoxicillin (tab/injection/syrup)	50	82.7
Gentamicin (injection)	21.2	65.4
Cotrimoxazole (syrup/tab)	50	71.2
ORS solutions	57.7	80.8
Zinc sulfate (tab)	34.6	46.2
Vitamin A syrup (bottle)	57.7	94.2
IFA syrup	53.8	90.4
Stadiometer	40	96.2
Weighing scale (salter)	97.5	98.2
Thermometer (digital)	97.5	92.3
Pulse oximeter (finger)	0	92.3

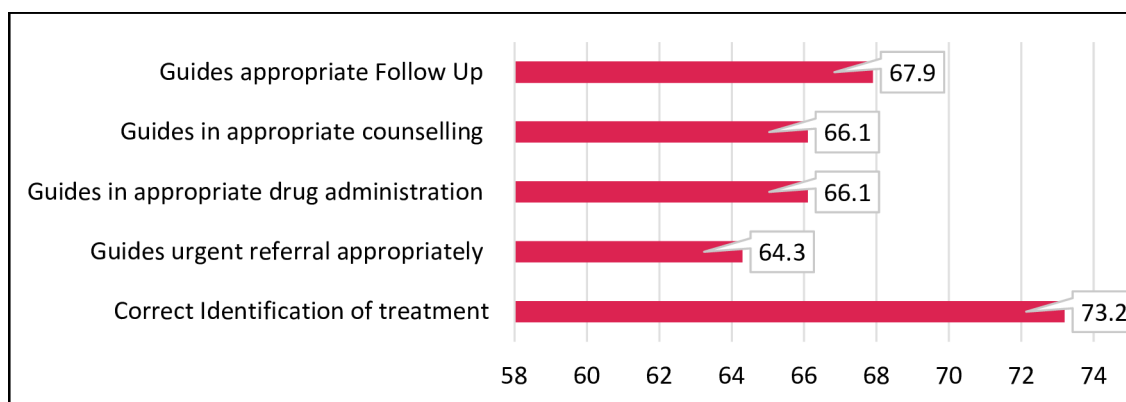
and the first point of ‘medical’ contact for beneficiaries covering a population of around 3000–5000 (~1000 households). ANMs at subcentres are the closest service provider to the community, within the health system and are pivotal in delivering IMNCI. Having competent peripheral health workers becomes critical<sup>16</sup> Despite the evidence-based guidelines, compliance varies at the point of care and adherence to IMNCI protocol remains a challenge. The use of IMNCI is seen to be limited by the extent of training, the insufficient supervision, the time it takes to follow the IMNCI chart booklet and the tendency to adhere to the protocol less rigorously over time.<sup>17</sup>

Effective implementation of IMNCI leads to improved prescribing patterns with reduced errors in correct case classification and prescriptions. However, there is heavy reliance on human memory and knowledge of the FLWs without significant real-time job aids and technology tools. Even though IMNCI trained health workers are supposed to consult the chart booklet and not depend on memory, this practice was not seen as prevalent in this study. It is known that decision-support systems can

help comply with specific standardised recommendations at the point of care.<sup>18 19</sup> This work shows ‘E-IMNCI’ tool supports the HCWs in following the algorithm of Assess, Classify, Identify, Treatment and Follow-up according to IMNCI protocol, with an automatic dosage recommendation, based on the symptoms to reduce classification and prescription errors. However, there are still challenges to effective implementation of the strategy, and factors like the long duration of IMCI training, poor supervision and lack of follow-up after training, all affect the performance of HCWs.<sup>20–22</sup>

There is evidence that the IMCI package if used digitally, results in better service delivery and robust real-time reporting. Implementation of E-IMCI in low-income countries has shown that HCWs accept the electronic version enthusiastically and there is an improved adherence to the IMCI protocols. This work further strengthens the earlier work done in Tanzania,<sup>23</sup> following the use of the E-IMCI app there was improved efficiency and adherence to the IMCI steps since the app allows and navigates through the IMCI chart and does not rely on the HCW to determine the next step. The clinical case management and counselling skills of ANMs improved using the E-IMNCI application for some but not all domains. There were improvements in the assessment of some signs like counting respiratory rate and not others such as chest indrawing, looking for visible severe wasting and breastfeeding assessment. It is likely that some assessments are more difficult for health workers and need more hand-holding for building capacity. While many signs are based on observation, signs such as counting respiratory rate were supported through the electronic breath counter in the application leading to improvement. Similarly, Oxygen Saturation (SPO<sub>2</sub>) measurements improved as pulse oximeters were supplied by the project based on discussions with the authorities. The ANMs also found various small videos and photos of convulsions, and diarrhoea informative and easy to follow. They also found demonstrations using the app to be a very powerful counselling tool.

The postimplementation assessment revealed that within a short span of 16 weeks of implementation, ANMs

**Figure 2** Perception of ANM about IMNCI protocol by using an E-IMNCI application. ANM, auxiliary nurse midwife; E-IMNCI, Integrated Management of Neonatal and Childhood Illness.

not only learnt to use the application but are also appreciating its usefulness in their regular job and have adopted it to a great extent. The observation of clinical management by health workers demonstrated that the practice of following IMNCI algorithms has improved at the respective health facilities and there is further scope for improvement with repeated use. While 64.3% of ANMs perceived that the app guides urgent referral appropriately, only 10% ANMs used the E-IMNCI application to refer a child as the number of cases requiring referral was small. One of the limitations of this work was the non-inclusion of the impact of the Hawthorne effect. This is unlikely to have a significant effect on case management quality as the same method was used for case management observations at baseline and postimplementation assessments.

The impact of the implementation was also seen as improved availability of medicine and equipment at facilities and is likely to be the result of the supportive supervision visits conducted by the project as the resource management tool integrated with the app has not been made fully operational with warehouse linkages. This work also suggests that a self-sustained process of learning can be built around the use of the application. The findings also corroborate that the real-time data submission with the help of this application became a reality paving way for timely and targeted consequent actions. In addition, with the challenges of a COVID-19 pandemic, the application has shown to be not only a great facilitator of IMNCI protocol but also helpful in the skill building of health workers. Thus, it is a great catalyst in building the eco-system of child survival through the community health infrastructure and catering to the need of underserved communities.

While we generated evidence on the usability and effectiveness of the app, we did not set up a system for the economic evaluation of the appropriateness and cost-effectiveness of the use of the app. Sustainability could not be assessed in the study even though the state government has expressed interest to continue using the app.

Similar work with a larger geographical area, increased number of health functionaries and prolonged duration of implementation with supportive supervision and full use of all features available with the app such as resource management tool can pave the way for countrywide scale up of e-initiatives.

## DISCLAIMER

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**Contributors** VA wrote the first and final draft, DB conducted the literature review, contributed to the design and implementation of the study and critically reviewed the draft manuscript. NK developed the tools and database, guided data analysis and tabular representation of the findings; AS supported in the data analysis and tabulation of data; KM supervised the research activity and provided complete oversight to the evaluation and assessment; PKS and JSM implemented the model in the state, supported in developing the study procedures and reviewed the results of the assessment; HK and AP conceptualised the design of the study and critically reviewed the manuscript. All authors have read and approved the manuscript. Guarantor, HK.

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**Patient and public involvement** Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

**Patient consent for publication** Not applicable.

**Ethics approval** This study involves human participants and was approved by institutional review board, No: 10068/IRB/20-21. Participants gave informed consent to participate in the study before taking part.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data may be obtained from a third party and are not publicly available.

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