To study the CEMONC services and its contribution towards reduction of maternal mortality in district Barwani of Madhya Pradesh"

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Abstract

Background: comprehensive emergency obstetric and newborn care (CEmONC) is a tertiary level health care initiative promoted in states and in their districts to reduce maternal and newborn mortality. Many agencies have extended their support in, including CEmONC training to providers, mentoring and monitoring through supportive supervision, provision of equipment and supplies, strengthening referral linkages, and improving infection-prevention practice, as package of interventions in 02 health care centers, covering barwani rural districts of Madhya pradesh to ensure timely CEmONC care. In recent years, there has been a growing interest in measuring program implementation strength to evaluate public health gains. To assess the effectiveness of CEmONC services initiative, this study measures its implementation strength and examines the effect of its variability across intervention health centers on the rate of facility deliveries and the met need for CEmONC services.

Methods: Before and after data from 02 intervention health centers were collected from April 2013 to July 2015. A CEmONC services implementation strength index was constructed from seven input and five process indicators measured through observation, record review, and provider interview; while facility delivery rate and the met need for expected obstetric complications were measured from service statistics and patient records. Results: The CEmONC services implementation strength index score, which ranged between zero and 12, increased statistically significantly from 4.3 at baseline to 7.7 at follow-up ($p < .06$). Correspondingly, the health center delivery rate significantly increased from 28% to 56% ($p < .05$). For every unit increase in CEmONC services implementation strength score there was a corresponding average of 4.5 percentage points (95% confidence interval: 2.7–6.9) increase in facility-based deliveries; while a higher score for CEmONC services implementation strength of a health facility at follow-up was associated with a higher met need.

Introduction

Globally, about 45% of maternal deaths and 36% of neo- natal deaths occur during the first 24 h after birth. Maternal and newborn deaths related to the perinatal period are largely preventable, and most life-threatening conditions are treatable if skilled health care is provided during the intrapartum and early postnatal periods at the primary health care level. However, in low- and middle-income state (LMIS),

where maternal and neonatal mortality is high, the availability, accessibility, and use of proven life-saving interventions for the treatment of obstetric complications are low. MP STATE OF INDIA made progress in improving maternal and child health during the Millennium Development The maternal mortality rate (MMR) dropped by 54% from 379 to 173 per 100,000 live births, while infant mortality decreased by 32% from 70 to 47 per 1000 live births. The reduction in the neonatal mortality rate (NMR) has been slow during that period and is currently 32 deaths per 1000 live births, accounting for 47% of all under-5 years mortality. Despite this decline, india state M.P is still regarded as among the highest in the world Moreover, the coverage of skilled attendance at birth and the met need for obstetric and newborn care are low . Committed to contribute toward achieving the maternal and newborn survival-related Sustainable Development Goals (i.e., to reduce global MMR to less than 70 per 100,000 live births and NMR to at least as low as 12 per 1000 live births by 2030. Madhya Pradesh state in india targets to reduce MMR to 100 per 100,000 live births by 2020. One of the key strategies promoted to reduce both maternal and newborn mortality in LMIS is the timely access to comprehensive emergency obstetric and new- born care (CEmONC) at secondary and tertiary level health center with the provision of at least the basic emergency obstetric and newborn care (BEmONC) at the primary health care level of a country's health system. To track progress in monitoring this strategy, the availability of CEmONC services, the proportion of all live births taking place in facilities, and the met need for C EmONC are among the key indicators that have been developed for the secondary and tertiary care level A systematic review of studies using quasi-experimental, observational, and ecological designs demonstrates evidence of the effectiveness of CEmONC interventions in reducing maternal mortality in LMIS. A recent intervention study in Madhya pardesh state of india suggests that upgrading facilities to provide life-saving interventions decreased the MMR and improved facility delivery rate Similar studies elsewhere demonstrate that implementation of CEmONC has significantly improved the facility delivery and the met need for CEmONC. Despite the availability of evidence of the efficacy of life-saving interventions to avert high rates of maternal and newborn deaths there is little understanding of how to deliver those interventions effectively Accordingly, intervention strategies need to be properly evaluated to identify successful, evidence-based, low-cost interventions, or implementation approaches that can be scaled-up, to promote their sustainable integration into health systems, and to ensure accountability to donors for public health gains Measuring the strength of program implementation is one of the evaluation approaches that helps to understand which packages of interventions are delivered effectively (and which are not) and why some programs are effective and attribute outcomes to program implementation characteristics However, in LMIS, there is a gap between knowledge of proven interventions and gains through implementation variations Strengthening the health care system to provide CEmONC is a key priority for providing life-saving services, especially in rural areas The Government of India took an initiative to improve access to CEmONC services by upgrading the capability of health centers at the country's secondary and tertiary health care level. Measuring the implementation strength of the CEmONC package of interventions

Study setting

The M.P health care system employs decentralized governance structures where regions are divided into zones, which are internally divided into districts. To respond to its population needs, the Government of india has restructured its health service into a three tier system of care: primary, secondary, and tertiary [16]. Primary level health care, the major platform for health service delivery at the grassroots level, in a rural district in M.P. India consists of many primary health center with four or five sub health centers. Each sub health center serve about 5,000 people in total. Primary health centers are staffed with health officers, nurses, midwives, and laboratory technicians to provide primarily preventive, curative, inpatient, ambulatory services, treatment of disorders, and other services. To reduce the high rate of maternal mortality in India, the Government expanded health centers to achieve a target of one health center providing all CEmONC functions for every 500,000 population. Moreover, the country sought to improve access to, and utilization of, CEmONC services by mobilizing communities to encourage pregnant mothers to give birth in health centers, expanding health centers, staffing health centers with midwives to ensure CEmONC services are always available, and providing ambulances to districts to mitigate transportation barriers

However, national evidence shows that most health centers were weak in providing life-saving CEmONC interventions, with only a few facilities providing all CEmONC functions. In most health centers, drugs, equipment, and supplies were missing, the centers were poorly staffed, or staff lacked the skills to apply most CEmONC functions. Moreover, the proportion of facility deliveries and the met need for CEmONC were low Strengthening health centers to provide all CEmONC functions remains a challenge. This is particularly so in rural health centers As such, the Ministry of Health and family welfare has set targets for facility delivery coverage at 90% and to enable all health centers to provide all CEmONC functions by 2015.

METHODS

The CEmONC initiative To upgrade the capability of health centers to provide timely CEmONC, tailored support was provided to 29 health centers, covering 1 rural districts of Madhya pradesh during the first phase of India CEmONC-strengthening initiative. This included CEmONC training to providers, mentoring and monitoring through post-training follow-up, provision of equipment and supplies, strengthening referral linkages, and improving infection-prevention practice.

Study design

A before and after evaluation for the CEmONC intervention included a cross-sectional survey conducted in April 2013 and July 2015, in 2 CEMONC centers in 1 districts of one regions: M.P, Nationalities, and Peoples' Region, and area. The effectiveness of the CEmONC initiative was determined by the several survey response relationships between CEmONC implementation strength (CIS) of the health centers and the outcomes of interest Conceptual framework.

A conceptual framework for measuring CIS was developed through a review of peer-reviewed and gray literature. Organizational structure (i.e., the resources of the health care system) and processes of service delivery are identified as components for measuring implementation strength. The structural components, well-documented in the literature, to provide quality CEmONC are a functioning facility with a skilled health service provider available around the clock and functional and adequate supplies, equipment, drugs, and infrastructure. An effective referral system is also critical to ensure a woman reaches the facility in a timely manner. The core elements of an effective referral system include formalized communication and transport, sufficiently resourced referral centers, active collaboration across all referral levels, protocols for the referrer and receiver, and accountability for providers' performances, coupled with supportive supervision .With regard to the process components, facilities must provide life saving interventions in a timely manner to respond to women's needs In addition, the project implementation pathway was analyzed by reviewing project documents and the Project Management Plan. The critical components necessary for measuring CIS in **rural** health centers to improve the use of critical maternal and newborn care services are 1) facilities' emergency readiness in terms of availability of services, human resources, equipment, and drugs; 2) effective referral; 3) the support system; and 4) adherence to basic life-saving interventions and quality of care.

Data

All 148 first-phase intervention health centers were visited during baseline and follow-up surveys. Data were

Table 2 Indicators used to measure CIS index score and their operational definitions

	Indicators	**Definition**	Data source
1	Number of CEmONC-trained personnel available	Number of CEmONC-trained providers (health officers, nurses, or midwives) working in the facility at the time of the survey	Interviews with facility heads
2	Number of laboratory tests available	Number of the following laboratory tests: hemoglobin/hematocrit, blood group, urine analysis, venereal disease research laboratory (VDRL), and HIV test for PMTCT available in the facility at the time of the data collection	Interviews with facility staff

3	Number of equipment available	Number of functional equipment, including oxygen concentrator, sphygmomanometer, vacuum extractor, suction machine, radiant heater, and Ambubag mask available in the facility for provision of CEmONC care at the time of the survey	Interviews with facility staff and observation
4	Number of drugs available	Number of the following drugs: intravenous (IV) uterotonics, IV fluids, Nifedipine, Hydralazine, IV antibiotics, IV $MgSO_4$ and calcium gluconate available in the facility for provision of CEmONC services at the time of the survey	Interviews with facility staff and observation
5	Number of ambulances	Availability of ambulance service in the facility 24 h a day	Interviews with facility heads

Provision of CEmONC signal functions

To obtain the CIS score. Thus, all the variables were given equal weights. The CIS index was recalibrated to range between zero and 10, with a higher score indicating better CIS. Cronbach's alphas were calculated to assess the internal reliability of the 12 items in measuring the underlying construct of CIS. The possible values of alpha range between zero and one, and values exceeding.70 are regarded as acceptable,The Cronbach's alpha for the 12 items was .71.The programmatic outcome variables of interest were the facility delivery rate and the met need for CEmONC. The facility delivery rate was defined as the proportion of deliveries that took place in health facilities out of the total expected number of births in the catchment area. The expected births were calculated based on information from the catchment projected population the population estimate of a health center based on the regional population growth rate estimate and the crude birth rate for the catchment area. This was calculated as the number of deliveries registered in health facilities in the last 12 months divided by the expected number of live births in that period and multiplied by 100. The facility delivery rate was calculated during the baseline and follow-up surveys. The met need for CEmONC was defined as the proportion of women with direct obstetric complications (including abortion complications, postpartum hemorrhage, obstructed or prolonged labor, and puerperal sepsis) treated at health centers in the last 12 months. It was calculated as the number of women with obstetric complications treated at health centers in the last 12 months divided by the estimated

number of women who would have obstetric complications (i.e., 18% of expected births) and multiplied by 100. The met need was measured only during the follow-up survey, as the information about obstetric complications was not collected during the baseline survey.

Statistical analysis

Data were analyzed for both descriptive and inferential statistics using Stataversion 13.6 Descriptive statistics were used to analyze the inputs and process of service delivery. A paired *t*-test was used to test the statistical significance of the changes in the indicators of interest Availability of a designated referral focal person to coordinate in- and out-referrals 24 h a day in the facility The following infection-prevention amenities and practices were observed at the time of the survey: clean facility compound, cleaning done after birth, availability of disinfectant solutions, disinfectant **solution** prepared and used correctly, availability of a container for sharps' disposal, providers practice hand washing, quality mechanism in place for sterilization, staff use personal protective barriers, availability of a light source for vaginal procedure, enough physical space, good illumination and ventilation, and easily washable delivery floor Provision of the following life-saving CEmONC services in the past 3 months for the treatment of obstetric complications; 9) removal of retained products of conception; 10) manual removal of placenta; 11) assisted vaginal birth; and 12) neonatal resuscitation between the baseline and follow-up surveys. An internal comparison group analysis was also done to assess relationships between CIS and the outcomes of interest, such as whether health centers with higher improvements in CIS were associated with increased facility delivery and the met need for CEmONC. Fixed-effects ordinary least-squares regression was used to assess the relationship between the changes in CIS found in the follow-up survey, compared with the baseline survey, and the changes in the health center delivery rate during the same period. Because information for the met need was available only at one point in time, during the follow-up survey, the cross-sectional relationship between CIS and met need was assessed using ordinary least-squares regression.

RESULT

The findings are presented in four sections: 1) change in CEmONC services over time, 2) changes in CIS and service utilization over time, 3) relationship between changes in CIS over time and changes in facility birth, and 4) relationship between changes in CIS over time and the met need for CEmONC at the secondary and tertiary health care level. Change in CEmONC services over time at the secondary and tertiary health care level in M.p country india Facility input indicators, including the availability of CEmONC-trained providers, availability of essential equipment, laboratory tests, and facility infrastructure, increased statistically significantly ($p <$ .05) over the study period (Table 3). The mean number of CEmONC-trained providers increased significantly from 1.4 at baseline to 2.6 during the follow-up survey ($p < .05$). Overall, the average number of laboratory tests available showed significant improvement over the survey periods with urine analyses and VDRL syphilis tests having improved significantly over time; however, hematological tests (hemoglobin and blood group) and HIV tests for PMTCT did not show statistically significant changes over time. Availability of individual drugs in the health centers showed significant positive changes for most drug categories except IV fluids and Nifedipine ($p < .05$). the availability of medical equipment, including vacuum extractor sets, radiant heaters, and oxygen concentrators, showed significant

change. As the values for the availability of IV fluids and sphygmomanometers were already high in the baseline survey, it would be difficult to see much improvement during the follow-up period; however, the availability of an ambulance service and a focal person to coordinate referrals showed significant improvements over the study period. Relationship between changes in CIS over time and changes in service utilization of facility birth provision at the secondary and tertiary care level Improvements in the CIS score over the study period were significantly associated with improvements in health center delivery: for every unit increase in CIS score across

Table 3 Input indicators measuring CIS at baseline and follow-up in 134 health centers

Indicator	Baseline	Follow-up	Change between baseline and follow-up		
			Charge	% CI	P value
Average number of CEmONC-trained providers	2.4	3.6	1.2	(.90,1.5)	<.001
Availability of laboratory tests (%)					
Hemoglobin/Hematocrit	61.5	64.5	3	.1,.1	.466
Blood group	89.1	91.4	2.3	.001,,.1	.439
Urine analysis	83.9	98.1	14	.01,.02	<.001
VDRL for syphilis test	63.7	91.6	17.9	.001..03	<.001
HIV test for PMTCT	99.2	95.5	-3.7	.002,.03	<.02
Average number of laboratory tests available	3.9	4.3	.4	.002..001	.23
Availability of equipment (%)					
Sphygmomanometer	86.6	88.8	2.2	(-.00,.001	.256
Oxygen concentrator	20.7	42.3	22.4	.1,.3	.001
Vacuum extractor (sets)	32.6	69.9	37.3	.3,.5	.001
Suction machine	34.8	48.2	14.6	.0,.3	.25
Radiant heater	33.6	57.5	24.1	.1,.3	.001
Ambu-bag & masks	88.8	97.8	9	.00,.2	.002
Average number of items of equipment available	32	42	10	.08,1.4	.25

time, there was a 4.5 percentage points increase in facility- based deliveries at health centers However, some health centers' CIS score declined over time, mainly due to the decline in the availability of medical equipment and infection-prevention amenities.

Relationship between changes in CIS score over time and the met need for CEmONC During the follow-up survey, facilities with a higher CIS score were associated with a higher met need for on average, every unit higher CIS score of a facility was associated with 3.1 percentage points higher met need for CEmONC.

Discussion

Our study is unique in reporting the effect of CIS on programmatic outcomes at the secondary and tertiary level of care.

The variability in CIS across health facilities and time has demonstrated a significant dose–response association with the key program outcomes: for every unit increase in CIS score, there was a corresponding average increase of four to five facility-based delivery rates at the health care centers. Moreover, a higher CIS score was associated with a higher met need for CEmONC. This study showed that facility input and process indicators increased significantly from the baseline survey, demonstrating an increased level of readiness for emergencies and management of common obstetric and newborn complications in health care facilities. However, some basic interventions like neonatal resuscitation and the manual removal of the placenta did not change significantly, which might be due to the lack of specific technical skills. Accordingly, focused and more intense mentoring and supportive supervision for particular skills, such as

Table 4

	Baseline	Follow-up	Change between baseline and follow-up		
			Change	(95% CI)	*p*-value
Practice to infection-prevention measures (%)					
Facility compound clean	70.6	75.9	5.3	(−0.0, 0.2)	.262
Cleaning done after attending birth	65.6	73.8	8.2	(0.0, 0.2)	.032
Availability of disinfectant solutions	89.5	97	7.5	(0.0, 0.1)	.001
Disinfectant solution prepared & used per standard	80	88.3	8.3	(0.0, 0.2)	.014
Availability of container for disposing of sharps	85.3	87.6	2.3	(−0.0, 0.1)	.256
Providers' practice hand washing	37.0	79.1	42.1	(0.3, 0.5)	<.001
Quality mechanism in place for sterilization	63.9	79.9	16	(0.1, 0.3)	.002
Staff use personal protective barrier	58.2	84.3	26.1	(0.2, 0.4)	<.001
Availability of light source for vaginal procedure	53.0	62.7	9.7	(−0.0, 0.2)	.144
Enough physical space	66.9	64.9	−2.0	(−0.1, 0.1)	.782
Good illumination and ventilation	89.5	79.9	−9.6	(−0.2, − 0.0)	.030
Easily washable delivery floor	70.7	77.6	6.9	(−0.0, 0.2)	.207

neonatal resuscitation and the manual removal of the placenta, could be implemented to improve these interventions.

The mean number of skilled birth attendants (midwives, nurses, and health officers) and pharmacy and laboratory professionals working at health centers available at the time of the survey were in line with the minimum requirements The implementation strength of CEmONC is strongly associated with

the improved availability and utilization of obstetric services in the intervention facilities, which ultimately will enhance the uptake of life-saving interventions to tackle the major causes of maternal and neonatal mortality. This indicates that investment in the CEmONC initiative to upgrade health facilities is effective. As such, policymakers and program planners should make additional investments in improving the availability of critical inputs for the provision of CEmONC and closely monitor the process of service delivery at the health facilities, to improve the utilization of maternal and newborn health services. Conventionally, the availability of CEmONC signal functions at health facilities is used to monitor CEmONC programs. The CIS can supplement and complement this by providing program input and process indicators that are essential for program managers to plan and monitor the provision of CEmONC services. Moreover, the CIS index predicts the CEmONC initiative outcomes well and has a good internal reliability. Thus, this would help to measure effort over time and gauge improvements of upgrading facilities for the provision of basic life-saving interventions and the effect of this effort on the utilization of maternal services outcomes at the secondary and tertiary level of care. It should be noted that the CIS index would serve to monitor CEmONC implementation status of a health facility at a glance; but is not suitable for making a programmatic decision. If the CIS index score is at its maximum or near its

Table 5 Changes in mean service utilization rate and CIS score at baseline and follow-up[a]

Indicator	Baseline	Follow-up	Change between baseline and follow-up		
	mean (SD)	mean (SD)	Mean (SD)	(95% CI)	*p*-value
CIS score	4.3 (1.8)	6.7 (1.8)	2.5 (2.1)	(2.1, 2.8)	<.001
Health center delivery	23.6 (19.6)	56.0 (27.6)	32.4 (30.8)	(27.1, 37.5)	<.001
Met need for CEmONC	–	16.0 (16.4)	–	–	–

[a]in 129health centers

maximum value then it can be concluded that all the components of the CEmONC interventions are being well implemented. However, if the CIS index score is not at the maximum or near the maximum value then individual items of the CIS index should be monitored to identify the areas with a gap. There are several limitations with this study. First, the study used a non experimental program evaluation design; as such, the effect estimates could be confounded by unmeasured variables and the presence of possible selection bias. Second, the CIS index is the aggregation of 12 items. As a result, measurement error in one of the items would potentially introduce measurement error to the composite indicator. The observed association between CIS and the outcome variables would likely be inconsistent if the measurement error of the CIS is systematic. Third, the change in data collection methods (paper- based during the baseline and Health-based during the follow-up) and different survey seasons between baseline and follow-up could bias the observed changes in the CIS index score and its components. However, these would be unlikely to affect the observed associations between the dependent and independent variables. Fourth, there is temporal ambiguity in the cross-sectional association between

the met need for CEmONC and CIS index. Lastly, the CIS measure did not include all vital program input indicators. For example, although all health centers under study received post-training follow up visits, the CIS index did not include whether any additional supervision and mentoring efforts were being provided as well as other supportive supervision efforts by hospitals and other partners, due to the problem of data verification as part of the CIS, which may have had a positive influence on the utilization of facility delivery and the met need for CEmONC We recommend further research on the quality of intrapartum care, the effect of CIS on the use of other maternal and newborn health services, equitable use of CEmONC services, and the cost of the CEmONC initiative. Provision of quality CEmONC services is an essential component for reducing maternal and newborn mortality rates As such, we recommend another study to investigate the effect of CIS on the obstetric complications case fatality rate, as well as on stillbirth and early neonatal death rates. Moreover, examining the effect of CIS on the utilization of other maternal and newborn health services is equally important. Improved uptake of CEmONC does not guarantee all women are using these services fairly; disadvantaged women might not access and use life-saving interventions. Disaggregated equity analysis of access to life-saving services would help health policy makers devise strategies to ensure equitable access to life-saving interventions for pregnant women who are beyond timely access to CEmONC and for poor women. Accordingly, we recommend other studies to examine the equitable use of CEmONC services by mothers. Furthermore, analyzing the cost of the CEmONC initiative is critical for policy- makers and program planners, as an evidence base to prioritize CEmONC and improve maternal and newborn health at the secondary and tertiary health care level. Finally, we used equal weights for the 12 items to construct the CIS index, which might be questionable. Thus, we would like to recommend further research to examine whether and how to give differential weights to different items measuring the CIS scores at the secondary and tertiary care level.

Conclusion

The CEmONC initiative was effective in improving institutional deliveries and may have also improved the met need for CEmONC services. Potentially, the CIS index, including its components, could be used to monitor the implementation of CEmONC interventions.

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