Field Testing of Second Generation of Colour-Coded Rings for Detecting Slow Progress of Labour at Rural Health Centres

Asha K. Pratinidhi¹ · P. P. Doke² · A. N. Shrotri³ · R. P. Patange⁴ · Vaishali Vhaval⁴ · Supriya S. Patil⁵ · Sujata V. Patil⁵ · S. V. Kakade⁵

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About the Author

Dr. Asha K. Pratinidhi, M. D. (PSM), D. P. H., D.C.H., is at present working as Director of Research in Krishna Institute of Medical Sciences Deemed University, Karad, Maharashtra. She has completed over 20 international and national research projects for WHO, UNICEF, ICMR and Government of India. She has edited a book ‘Primary Perinatal & Neonatal Health Care’ and published over 120 international and national research papers in indexed journals and filed 10 patent applications. She has received “Mahajan Award” for the Best Published Paper and Best Paper Award for two oral presentations of Research Society of B. J. Medical College, Pune. She is working as Editor-Chief of Journal of Krishna Institute of Medical Sciences University (JKIMSU).

Asha K. Pratinidhi is Director of Research at Krishna Institute of Medical Sciences Deemed University; P. P. Doke is Professor in Community Medicine Department at BVDU Medical College; A. N. Shrotri is Ex. Professor, B.J. Medical College, Pune, India; R. P. Patange is Professor and Head in Department of Obstetrics and Gynecology at Krishna Institute of Medical Sciences; Vaishali Vhaval is Assistant Professor in Department of Obstetrics and Gynecology at Krishna Institute of Medical Sciences; Supriya S. Patil is Associate Professor in Department of Community Medicine at Krishna Institute of Medical Sciences; Sujata V. Patil is Associate Professor in Department of Community Medicine at Krishna Institute of Medical Sciences; S. V. Kakade is Associate Professor in Department of Community Medicine at Krishna Institute of Medical Sciences.

✉ Asha K. Pratinidhi
ashapratinidhi@gmail.com

¹ Krishna Institute of Medical Sciences Deemed University, Karad, India

² Community Medicine Department, BVDU Medical College, Pune, India

Abstract

Introduction An innovative appropriate technological tool of colour-coded rings based on cervicographic principles was developed to monitor deliveries.

Objectives To study efficacy, feasibility and acceptability of colour-coded rings for monitoring active phase of labour.

Materials and Methods All consecutive deliveries occurring at selected primary health centres from Pune, Satara and Kolhapur Districts of Maharashtra, during 15 months period were included in the study and matched control groups.

³ B.J. Medical College, Pune, India

⁴ Department of Obstetrics and Gynecology, Krishna Institute of Medical Sciences, Karad, India

⁵ Department of Community Medicine, Krishna Institute of Medical Sciences, Karad, India

Training of medical officers and nurses from both study and control area was undertaken in routine natal and post-natal care. In addition, training of use of colour-coded rings was given to health workers from the study area.

Results There were 6705 live births from study area and 6341 from control area. Perinatal mortality rate for study area was 15.9/1000 LB while that was 23.9/1000 LB for control area ($p < 0.01$). The cause-specific perinatal mortality due to birth asphyxia for the study area was 4.2/1000 LB while that was 8.5/1000 LB for control area ($p = 0.0019$).

Conclusion Higher use rate of colour-coded rings associated with reduction in cause-specific mortality rate due to birth asphyxia in study area indicated that use of colour-coded rings is effective, feasible and acceptable option to cervicography under field conditions.

Keywords Birth asphyxia · Colour-coded rings · Slow progress of labour

Introduction

There are very high stillbirth rate (SBR) and early neonatal mortality rate (ENMR) in India. The perinatal mortality rate (PNMR) at the time of study in India has been 37/1000 LB (rural 41 urban 24) [1], the two most important causes being birth asphyxia and prematurity [2]. Prolonged and obstructed labour is an important and preventable cause of birth asphyxia.

Majority of Indian population (around 70 %) resides in rural area [3] with limited access to expert obstetric care. Women deliver in rural hospitals, primary health centres, sub-centres, private maternity units or sometimes even at home. The birth attendants more often than not are nurse midwives, traditional birth attendants or at times relatives of the mothers.

World Health Organization (WHO) has recommended use of partograph for all deliveries taking place in developing countries for timely referral of cases showing slow progress of labour [4]. Partography, though recommended for monitoring of labour, is not used in practice and is one of the strategic interventions that is missing or inadequately being implemented in India.

An appropriate technological tool of colour-coded rings (CCR) based on the principles of cervicography was therefore developed [5] and tested in the rural area of Pune District of Maharashtra, India [6], with encouraging results. The tool developed for all categories of the birth attendants aimed at recognition of onset of active phase of first stage of labour, and periodic accurate assessment of cervical dilatation thereafter for determining the progress of labour as satisfactory or slow, thus needing intervention.

In view of the changes in the modified WHO partograph [4] with commencement of active phase of labour around 4 cm of cervical dilatation, a second generation of set of CCR was prepared for this study.

Field testing of this appropriate technological tool based on the principles of cervicography for efficacy, feasibility and acceptability was undertaken as one of the objectives in National Rural Health Mission (NRHM) supported project entitled “Field Testing of Appropriate Technology Tools for Monitoring of Slow Progress of Labour and Growth of LBW Babies below 2500gm at PHC/RH Level”. Results of use of CCR while managing labour at rural health centres are presented in this article.

Materials and Methods

The study was undertaken from March 2009 to July 2012 in three districts of Maharashtra namely Pune, Satara and Kolhapur, by a team of investigators consisting of obstetricians, public health experts and a statistician from Krishna Institute of Medical Sciences, Karad.

Sample Size

The PNMR in rural Maharashtra at the time of planning the study was 26/1000 LB [7]. With intervention of use of CCR for detection of slow progress of labour, it was expected to be reduced by one-third, i.e. by 33 %. Thus, minimum sample size of 4527 was required to test 33 % reduction in perinatal mortality with 95 % confidence level and 80 % power.

We decided to monitor a total of 6000 deliveries by CCR for judging satisfactory progress of labour during first stage (about 2000 deliveries from each district) to fulfil the minimum sample size, as based on the prior experience that about 20–25 % women will deliver within 2 h of admission to health care facility. In these women arriving in advanced labour, the use of CCR either could be irrelevant or could be possible only on one occasion as delivery would occur before the second scheduled vaginal examination.

Study Area and Sampling

In order to reach the desired minimum sample size, a matched multistaged sampling procedure was adopted.

Stage I—All talukas in the three study districts were matched and paired depending upon their performance ranking related to mortality and coverage indicators of MCH and distance from the headquarter town of the district.

These matched paired talukas were randomly allocated to study and control areas.

Stage II—All primary health centres (PHCs), where deliveries were routinely conducted, however, facilities for comprehensive emergency obstetrical and paediatric care did not exist were enlisted. While reaching the desired number of 2000 deliveries for each district, these health centres were considered, ranked and selected according to the cumulative frequency of annual deliveries for the preceding year from highest number giving equal weightage to each of the taluka from the study and control areas for each of the districts.

Inclusion Criteria for Delivering Women

All deliveries taking place in the selected rural centres were monitored. All stillbirths were recorded and all live-born babies were followed till 7 days and survivals and deaths were identified. All births taking place in the selected health centres in the resident population were included in the study.

Exclusion Criteria for Delivering Women

All deliveries occurring at home or any other place other than selected health centres and women coming only for delivery having plans to leave the study area before 7 days after delivery were excluded from the study. An informed consent was obtained from all the eligible women. Clearance from the institutional ethics committee was obtained before commencement of the project.

Development of Second Generation of Colour-Coded Rings

The first generation of CCR denoting the active phase transition at 3 cm was developed for the earlier study as the

active phase of labour was earlier considered at 3 cm cervical dilatation. It consisted of four pairs of rings, one small and one big of the same colour.

In view of the observed need to simplify the concept of cervicographic assessment of progress of labour, and in view of the introduction of modified partograph by WHO in 2000 [8], a set of second generation of CCR was developed starting from 4 cm for this project. This consisted of two subsets of small-, middle- and large-sized rings in two different colours, one set of rings of 4, 6, 8 cm diameter (yellow) and the other subset of 5, 7, 9 cm diameter (green) (Fig. 1b). They were mounted on an acrylic board.

Colour coding and marking of arrows were done with an objective of giving visual impression of initial and expected sizes of cervix during the active phase of the first stage of labour at the end of 2 and 4 h after first vaginal examination. There were two subsets of small-, middle- and large-sized rings each subset represented by different colour mounted on an acrylic board in the second generation of CCR.

If the initial size of the cervix was equal to the small ring of given colour and if the size of the cervix was lesser than big-sized ring of the same colour after 4 h, it would indicate that the labour is getting delayed and the woman should be referred for expert care for review of the case followed by augmentation of labour by artificial rupture of membrane (ARM) or oxytocin drip as appropriate. If there was a need for doing vaginal examination at 2 h, then the expected cervical dilatation would be indicated by the mid-sized ring of the same colour, and if the dilatation was lesser than that, there was a need for further careful monitoring. For calculation of expected cervical dilatation at the end of 3 h, an hourly expected ring size was given on the mounted set of CCR.

Fig. 1 **a** First generation of unmounted colour-coded rings. **b** Mounted colour-coded rings showing expected cervical dilatation in centimetre over period of time

Training of Health Care Workers

A 1 day training was given to health care workers (HCWs) (130 MOs and 151 nursing staff) of 62 study and 68 control health centres in routine natal and post-natal care under RCH phase II programme including partographic monitoring. The improvement in the knowledge was tested by self-administered multiple choice questions.

Interpretation of given cervical dilatation at the end of a given period was tested by giving examples of five hypothetical cases. Observations were made on filling up of partograph during training.

In addition, a 1-day training was given to all HCWs including MOs from the study area to correctly identify the size of rings in centimetre and to identify the ring of correct expected size after given duration of time in hours of commencement of active phase of labour.

The skill of judging the diameter of the ring was tested using simulation training device [5] which has rings of increasing diameter from 3 to 10 cm fitted on a rotating drum. (Fig. 2)

The device has a hole (I) through which the rings can be seen, and if the curtain is drawn to cover the hole, the vision can be blinded. The device has an indexing mechanism with a handle by which a desired sized ring can be brought in the centre (II). After initial assessment of the skill by blinding, the doctors and nurses were allowed to see the ring sizes and palpate the rings till they perfected visual and tactile judgement of sizes of the rings.

Skill assessment was undertaken after training with the curtain on to blind them. It was ensured that all the trainees from study area were able to grasp the skills of judging ring diameter which was a proxy for cervical dilatation, interpreting the cervical dilatation progress after 2 and 4 h as

satisfactory or slow and, need for augmentation of labour/referral.

The HCWs from the study centres were handed over a mounted set of CCR to be displayed in the labour room of the PHC and instructed to use it to identify delayed labour and maintain its record.

Provision of Care in Study and Control Area

Services provided and referral care in study and control area to the mothers and babies were as per guidelines under RCH II. In addition, in study area CCR were used during labour to identify slow progress of labour during active phase of first stage of labour.

Data Collection

In both study and control rural centres, the data were collected about delivering women which included socio demographic data, information related to previous pregnancies, current pregnancy, duration of labour after arrival at the centre, progress of labour as documented by cervical dilatation and outcome of labour on pretested questionnaire. The details of referrals and outcome of referrals were noted. Additionally, in study centres data regarding use of CCR and the interpretation regarding progress of labour were found out. The referrals based on use of CCR were analysed.

Actual data collection for the project was undertaken from 1 May 2010 after pilot testing for 1 month. All consecutive eligible women coming for delivery in the selected PHCs and their babies from study and control area over a period of 15 months from 1 May 2010 to 31 July 2011 were included in the study. All the live-born babies were followed for 1 week. A senior research officer was specially appointed for the project for each district, to guide and supervise the project work. The information from birth attendant and referral centre was collected to ascertain the cause of death.

SPSS version 20 was used for statistical analysis.

Results

The knowledge of medical officers regarding intra-partum and post-partum care improved significantly from a mean score of 13.9 to 17.3 ($t = 11.95$, $p < 0.0001$) and the knowledge of nurse midwives also improved significantly from pre-training mean score of 11.65 to 15.30 ($t = 11.63$, $p < 0.0001$). Majority of the male medical officers were not able to judge the diameter of the rings correctly or express it in centimetre. They were also not able to plot the cervicograph before training. There was a lot of confusion about cervicograph, and none of the ANMs could express cervical dilatation in centimetre in pre-training skill

Fig. 2 Simulation training device. I Circular hole of the device to see the rings. II Indexing mechanism

Table 1 Distribution of live births, still births, early neonatal deaths (END) and perinatal deaths (PND) in study and control area

District	Study area				Control area			
	Live births	Still births (SBR)	END (ENMR)	PND (PNMR)	Live births	Still births (SBR)	END (ENMR)	PND (PNMR)
Pune	1699	28 (16.4)	5 (2.9)	33 (19.4)	1610	39 (24.5)	11 (6.8)	50 (31.1)
Satara	2172	34 (15.6)	9 (4.1)	43 (19.8)	1723	43 (25.2)	14 (8.1)	57 (33.1)
Kolhapur	2834	24 (8.5)	7 (2.5)	31 (10.9)	3008	35 (11.7)	10 (3.3)	45 (14.9)
Total	6705	86 (12.8)	21 (3.1)	107 (15.9)	6341	117 (18.5)	35 (5.5)	152 (23.9)

SBR, still birth rate/1000 LB; ENMR, early neonatal mortality rate/1000 LB; PNMR, perinatal mortality rate/1000 LB

Table 2 Cause-specific PNMRs in study and control area

Cause of death	Study area			Control area		
	Still births (SBR)	END (ENMR)	PND (PNMR)	Still births (SBR)	END (ENMR)	PND (PNMR)
LBW and prematurity	38 (5.7)	6 (0.9)	44 (6.6)	43 (6.8)	12 (1.9)	55 (8.7)
Birth asphyxia	20 (3.0)	8 (1.2)	28 (4.2)	45 (7.1)	9 (1.4)	54 (8.5)
Congenital malformation	5 (0.7)	2 (0.3)	7 (1.04)	2 (0.3)	3 (0.5)	5 (0.8)
Death before arrival to hospital	16 (2.4)	0 (0.0)	16 (2.4)	17 (2.7)	0 (0.0)	17 (2.7)
Neonatal infections	0 (0.0)	4 (0.6)	4 (0.6)	0 (0.0)	8 (1.3)	8 (1.3)
Other	7 (1.04)	1 (0.15)	8 (1.2)	10 (1.6)	3 (0.5)	13 (2.1)

assessment on simulation training device and plot the observations on cervicograph correctly. Their practice was to express cervical dilatation in fingers and not in centimetre. There was a marked improvement in judging and expressing ring diameter in centimetre after training.

Routine use of partograph was not practised at all in any of the selected PHCs from study and control area, although partography training was received by majority of them. The practice of plotting of cervicograph improved after training in both study and control area. After use of CCR, the correct plotting of cervicograph improved to 86.2 % in the study area as compared to 51.3 % in control area. This difference in plotting of cervicographs was statistically highly significant ($\chi^2 = 1882.5$, $p < 0.0001$).

All the deliveries taking place in the study and control area and the outcome of birth are given in Table 1. There were 6761 deliveries from study area and 6413 deliveries from the control area.

Overall PNMR of study area was 15.9/1000 LB which was significantly lower than the control area of 23.9/1000 LB ($\chi^2 = 10.753$, $p < 0.01$). Also overall still birth rate and ENMR of study area were significantly lower than the control area ($\chi^2 = 6.168$, $p = 0.013$ for SBR) ($\chi^2 = 4.347$, $p = 0.0371$ for ENMR).

The perinatal mortality due to birth asphyxia in the study area was significantly lower (Table 2) as compared to control area ($\chi^2 = 9.669$, $p = 0.0019$). A significantly lower cause-

specific mortality due to birth asphyxia of 3.0/1000 LB in SBR component in study area as compared to 7.1/1000 LB in control area was observed ($\chi^2 = 10.311$, $p = 0.0013$). However, contribution of birth asphyxia to ENMR in study and control area did not show significant difference ($\chi^2 = 0.01326$, $p = 0.9083$). There was no significant difference in the distribution of any other cause of perinatal mortality between study and control area. The lower stillbirth mortality as well as perinatal mortality can be attributed to the lesser number of deaths due to birth asphyxia.

Reasons for Referrals in Mothers

In all, 997 (14.8 %) women out of 6761 deliveries from study area and 957 (14.9 %) women out of 6413 deliveries from control area were referred for emergency obstetrical care during delivery. Most common reason for referral was delayed labour amongst 329/6761 (4.9 %) women from study area and 214/6413 (3.3 %) from control area. Premature rupture of membranes, foetal distress and pregnancy-induced hypertension were the other important reasons for referral apart from delayed labour.

The overall use of CCR was 88.6 % (85.3 % in Pune District, 86.7 % in Satara District and 92.1 % in Kolhapur District). In 11.4 % women, CCR were not used at all, and in 24.1 % women, it was used only once as these women delivered within two hours of first vaginal examination.

Table 3 Outcome of delivery of 85 women detected as delayed labour by CCR alone

	No.	%
Delivered at Health Centres before referral		
After augmentation—by ARM	10	11.8
After augmentation—by oxytocin	9	10.6
Delivered after referral at referral centre		
Without intervention	9	10.6
After augmentation with oxytocin	22	25.9
Forceps	16	18.8
LSCS	19	22.3
Total number identified as delayed labour		
by CCR alone without any underlying cause	85	100

Thus, in total of 35.5 % women, CCR were not used for two vaginal examinations. Amongst 4361 women, after first vaginal inspection in 30.2 % women second vaginal examination was carried out within 2 h, in 58 % between 2–3 h, in 6.6 % between 3–4 h and in 5.2 % after 4 h. Out of all women in whom two vaginal examinations were undertaken, 34.75 % showed higher rate of cervical dilatation, 29.37 % had lesser than expected cervical dilatation and remaining 35.88 % women showed dilatation at expected minimum rate during active phase of labour. There were many underlying causes associated with delayed progress of first stage of labour. Out of 4361 women in whom two vaginal examinations could be carried out, 329 (7.5 %) were identified as slow progress of labour at the end of 4 h of first vaginal examination after use of CCR. In 244 (5.5 %) of them, some specific cause such as abnormal presentation, leaking membrane, cord around the neck were present, and in 85 (1.9 %) women, there was no other apparent cause for delay and delayed labour was identified by use of CCR alone.

Nineteen women delivered after augmentation of labour by ARM or oxytocin drip at health centres from study area, and 66 women were referred without any other indication for referral. Out of 66 women referred for delayed labour, 9 women delivered without any intervention, 22 delivered after augmentation with oxytocin, 16 needed forceps and 19 needed caesarean section (Table 3).

Discussion

The Millennium Development Goals (MDG) 4 and 5 aimed at three-fourth reduction in maternal and childhood mortality by 2015 from the level of 1990 [9, 10]. Prevention of prolonged labour is an important aspect of reducing maternal and perinatal mortality and morbidity.

WHO published the first composite partograph for documentation of labour progress in 1988. WHO modified the partograph for use in hospitals in 2000 with exclusion of latent phase and commencement of active phase at 4 cm, keeping the other features the same as the composite WHO partograph. The Government of India has introduced the simplified partograph in competency-based skilled birth attendant (SBA) training of midwives and medical officers during 2005 under NRHM [11]. It is now expected that every delivery should be conducted by a SBA and the woman should be monitored partographically.

Although the partograph is a simple and inexpensive tool, it is not utilized widely. The medical officers and nursing staff have received extensive training in partography, but still it is rarely used in the field conditions although modified partograph is easier to use and tabulate. Studies from Kenya did report that only 25–33 % of care givers surveyed were using partograph for routine monitoring [12]. The reasons for non-use of cervicography by paramedics were mainly their practice of expressing cervical dilatation in fingers and not in centimetre and limited education and inability to understand and plot graph. For this very purpose, CCR were tried which used objective criteria of centimetre and not fingers to denote size of a hole. It is therefore likely that use rate of this simple device was 88.6 % where visual and tactile acquisition of skill and ready recogniser in the form of CCR in identifying existing and progressive size of the cervix in centimetre could have made the difference in use and non-use of a method.

Realizing the need for an acceptable method of monitoring of first stage of labour, a simple appropriate technological tool of CCR was developed during dissertation work of Dr. K. S. Patil M. D. (PSM), University of Pune [5, 13]. A feasibility study was undertaken by Pratinidhi et al. [14], with encouraging results. This first generation of CCR were based on the cut-off point for active phase of labour of 3 cm which was recommended at that time by WHO. Present second-generation CCR are based on the cut-off level of 4 cm for active phase of labour as recommended by WHO subsequently and field tested in this project.

A simulation training device was developed to train the birth attendants in identifying the rings having diameter of a given size from 3 to 10 cm by visual and tactile perception in earlier project supported by Government of India [6] which was used in this study for training.

Partographic principles need to be understood in countries like India where we wish to utilize peripheral staff and non-obstetricians as a workforce for care during childbirth. As we do not have effective peripheral level comprehensive emergency obstetrics services, it is very crucial that every labouring woman should be referred in a timely manner in order to improve maternal and neonatal outcomes. This could be achieved by monitoring of labour by

using a simple tool based on cervicographic principles. This simple tool can be used for upscaling the skill of birth attendant in identifying correct size of the cervix in centimetre and predicting minimum expected dilatation of cervix at the time of second vaginal examination.

The significant difference observed in the reduction in deaths due to birth asphyxia in the present study could be attributed to the use of CCR for identification of delayed labour, appropriate referral and good newborn care including resuscitation of the newborn at rural health centres and the referral centre. Use of this translational research tool of CCR obviates graphical recording of findings on the cervicograph for each delivering woman. All other parameters included in the partograph for monitoring maternal and foetal condition are already being recorded routinely on the case paper as per the local practices mostly in tabular format.

A multiple-centre trial in Southeast Asia involving 35,484 women for testing partograph has shown reduction in stillbirths from 0.5 to 0.3 % in 1994 [15]. In this project, stillbirth rate has been significantly lowered in the study area as compared to the control area (18.5/1000 LB to 12.8/1000 LB).

Colour-coded rings were prepared on the basis of the principles of cervicography. It is therefore not surprising to see the beneficial effect of the CCR similar to those observed with use of cervicograph.

This tool has been helpful for the ANMs for identifying the slow progress of labour and prompt referral so as to achieve reduction in deaths due to birth asphyxia. The same mounted CCR as a translational and appropriate technological tool can be used for training and assessment of skill of birth attendants in identification of correct size of cervical diameter in centimetre and identification and decision-making regarding slow progress of labour by the health workers.

A high use rate of CCR of 86.2 % and 33.5 % significant reduction in PNMR and 57.7 % cause-specific mortality due to birth asphyxia indicate efficacy, feasibility and acceptability of use of CCR by ANMs.

Limitations of the Study

1. Although the number of cases enrolled at the PHCs for delivery is statistically appropriate, the number of referrals due to delayed labour is relatively small (329/6761, i.e. 4.9 % in study area, and 214/6413, i.e. 3.3 % in control area). This study therefore can be considered as a pilot study and further studies on large scale and of longer duration should be undertaken before recommending CCR for the general use in maternal and child health programme, although results of this field testing CCR are encouraging.

2. Cervicography cannot replace partography as partography has many other maternal and foetal parameters to monitor the labour. CCR can to some extent be used instead of cervicograph to some extent.

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Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional ethics committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants added in the study.

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