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Using quality improvement methods to test and scale up a new national policy on early post-natal care in Ghana

Nana AY Twum-Danso,[1] Ireneous N Dasoberi,[2] Isaac A Amenga-Etego,[2] Ane Adondiwo,[2] Ernest Kanyoke,[2] Richard O Boadu,[2] Solomon Atinbire,[2] Phoebe Balagumyetime,[3] Francisca Bagni,[3] Chrysanthus Kubio,[3] Isabella Sagoe-Moses[3] and Pierre M Barker[1]*

[1]Institute for Healthcare Improvement, 20 University Road, 7th floor, Cambridge, MA 02138, USA, [2]National Catholic Health Service, P.O. Box KA 9712, Accra, Ghana and [3]Ghana Health Service, PMB Ministries, Accra, Ghana

*Corresponding author. Institute for Healthcare Improvement, 20 University Road, 7th floor, Cambridge, MA 02138, USA. Tel: +1-617-301-4800. Fax: +1-617-301-4848. E-mail: pbarker@IHI.org

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Introduction The first week of life presents the greatest risk of dying for a young infant. Yet, due to the sociocultural, financial, geographical and health system barriers found in many resource-poor settings, infants do not access health care until much later. To reduce neonatal mortality, the Ghana Health Service proposed a new policy that promotes skilled care during the first week of life. We report the results of an initiative that uses quality improvement (QI) methods to test the feasibility and effectiveness of the new early post-natal care (PNC) policy and its subsequent scale-up throughout northern Ghana.

Methods Over a 10-month period, 30 networked QI teams from 27 rural health facilities developed and tested both facility-based and community-based changes to their processes of maternal and neonatal care. Coverage and outcome data were analysed using an interrupted time-series design.

Results Over 24 months, early PNC increased from a mean of 15% to 71% for visits within the first 48 h, and from 0% to 53% for visits on Day 6 or 7. We observed a slower increase in skilled delivery (mean of 56% to 82%) over a longer period of time (35 months). Facility-based neonatal mortality remained unchanged: mean of 5.1 deaths per 1000 deliveries. Using the most effective change ideas developed in the 27 test facilities, the early PNC policy was scaled up over the subsequent 2 years to 576 health facilities in all 38 districts of northern Ghana.

Conclusions This initiative demonstrates the utility of a QI approach in testing, implementing and subsequent scaling up a national policy for early PNC in a resource-constrained setting. This approach provides a model for improving the implementation of other national health policies to accelerate the achievement of the Millennium Development Goals in Ghana and other resource-poor countries.

Keywords Quality improvement, implementation science, post-natal care, neonatal mortality, large-scale change, Ghana

KEY MESSAGES

- Two years after a new national policy for early post-natal care was introduced in Ghana coverage within 48 h of life increased from 15% to 71% and on Day 6 or 7 of life from 0% to 53%.
- Quality improvement methods provide a model for testing and scaling up new national health policies in resource-poor settings.
- Enabling frontline providers to develop context-specific strategies with the communities they serve fosters rapid implementation of new health policies.

Introduction

While global mortality rates in children younger than 5 years of age (under-5) declined between 1970 and 2010, the decline for neonates (children 28 days old or younger) was minimal (Rajaratnam *et al.* 2010). Deaths in the neonatal period accounted for approximately 40% of the estimated 7.7 million under-5 deaths in 2010 (Rajaratnam *et al.* 2010). Fifty percent of neonatal deaths are estimated to occur on the first day of life, while an additional 25% occur by the end of the first week (Lawn *et al.* 2005). About 80% of neonatal deaths are caused by intra-partum asphyxia, infections and complications of premature birth, all three of which are largely preventable or treatable if skilled health care is provided during the intra-partum and early post-natal periods (Lawn *et al.* 2005, 2010).

In Ghana, the Demographic and Health Survey reported a decline in under-5 mortality from 110 to 80 per 1000 live births between 2003 and 2008, but relatively little change in neonatal mortality rates which have fluctuated between 30 and 43 deaths per 1000 live births since the mid-1990s (Ghana Statistical Service *et al.* 2009). Similar to the global pattern, neonatal mortality in Ghana comprised about 40% of all under-5 mortality (Ghana Statistical Service *et al.* 2009). While the medical strategies to save newborn lives are well described, cost effective and applicable to low-resource settings (Darmstadt *et al.* 2005, Kerber *et al.* 2007, Lawn *et al.* 2010), these interventions cannot be applied if the mother and newborn do not access health care during the most vulnerable intra-partum and early post-natal periods. In rural areas of Ghana, provision of early post-natal care (PNC) has been limited by a low coverage of skilled delivery of 43% (compared with 84% in urban areas) (Ghana Statistical Service *et al.* 2009); cultural perceptions which delay care-seeking for sick newborns (e.g. perception of neonatal life as transient and some neonatal illnesses as spiritual; Bazzano *et al.* 2008); and absence of a preventive care policy in the first week of life. Even for those women who deliver in health facilities, the majority are discharged within 12 h for a variety of reasons including lack of space, lack of bathing facilities, lack of catering services, personal preference of the post-partum woman to return home quickly to attend to other children or household duties or to perform cultural rites with the placenta (I Sagoe-Moses, personal communication).

The initial child health policy in Ghana did not promote the first contact between health staff and newborns until the second week of life, while the second contact was scheduled for 6 weeks of age when most childhood immunization and growth monitoring programmes start (Ministry of Health Ghana 1999). This policy was subsequently improved to promote the first contact in the first 3 days of life, while the second contact remained at 6 weeks (Ministry of Health Ghana 2003), but this did not allow for monitoring during the most vulnerable period for neonatal survival (Lawn *et al.* 2005, 2010). Therefore, as part of its efforts to further reduce neonatal mortality and accelerate progress towards Millennium Development Goals (MDG) 4 and 5, focused on child and maternal survival respectively, the Ghana Health Service (GHS) proposed, in October 2008, a new post-natal/post-partum policy that promotes skilled health care during labour, delivery, and the immediate post-partum period, and two surveillance visits within the first week of life to encourage healthy behaviours and detect early warning signs of illness in both mother and child. The term PNC used hereafter includes care of both the mother and the child during labour, delivery and the subsequent 7 days.

Given the challenges in the rural areas of long distances between communities and health facilities, limited road networks, scarce transportation, low staff-to-population ratios and substantial cultural barriers to acceptance of modern medicine especially for neonates (Bazzano *et al.* 2008; Ngom *et al.* 2003), the best way to implement this new early PNC policy was unknown. Specifically, it was unknown whether (1) health facilities would have sufficient space to accommodate all post-partum women for at least 24 h; (2) women would be willing and able to stay that long for monitoring; (3) women would be able to return to the health facility by Day 7; and (4) health staff would have the time and logistics to conduct home visits for those who did not return by Day 7. We report a multi-district, post-hoc observational study of the initial test of the feasibility of implementation of the new early PNC policy and subsequent scale-up throughout 3 out of the 10 health administrative regions of Ghana using quality improvement (QI) methods over a 3-year period. This work represents a subset of a nation-wide QI project (Twum-Danso *et al.* 2012) to accelerate Ghana's progress towards MDG 4 that began in July 2008.

Methods

Context

GHS's new early PNC policy was tested in one Catholic diocese and three districts in the three health administrative regions of northern Ghana by health staff in 25 health centres, 2 hospitals and 3 district health management teams (DHMTs). These locations were selected purposefully to take advantage of the QI intervention that had begun in those sites 3 months earlier as

the initial phase of a four-phased national scale-up QI project focused on maternal and child health. In addition, the government introduced a policy for free national health insurance (NHI) for maternity and early infant care throughout the country 3 months before testing of the new PNC policy began. The NHI policy required pregnant women to register with a district-based health insurance scheme in order to be eligible for free health care at accredited facilities. Health providers were not provided with any financial incentives as part of this free NHI policy or the QI intervention. Ghana's national Maternal, Newborn and Child Health (MNCH) programme was already in place in all districts in the country, although the reliability of implementation was variable. We were not aware of the of any other facility- or community-based health interventions that were being introduced to promote MNCH in the intervention sites at that time. Impact evaluation and cost-effectiveness analysis of the overall QI intervention is ongoing and will be published elsewhere.

Each hospital had only one physician and served as a referral centre. The health staff formed 30 multidisciplinary QI teams to operationalize the new early PNC policy at the local level. Fifty percent of the participating QI teams were from GHS, while the other 50% were from the National Catholic Health Service (NCHS), the second largest provider of health-care services in Ghana. The intervention was designed to assess whether there was a difference in performance between the two types of ownership. The estimated population served was 250 000 and the number of deliveries expected per month was about 760.

The catchment area is very rural, with limited road, transportation and communications infrastructure. Subsistence agriculture is the main occupation. Literacy in the region ranges from 26% to 34% for females and from 44% to 55% for males (Ghana Statistical Service *et al.* 2009). Between 2007 and 2010, Ghana's gross domestic product (GDP) real growth rate varied from 4.1% to 7.3% (http://www.indexmundi.com/g/g.aspx?c=gh&v=66), while government expenditure on health as a percentage of GDP remained below 5% (http://www.indexmundi.com/facts/ghana/health-expenditure).

In addition to providing skilled care during labour, delivery and the immediate post-partum period, the new early PNC policy required two surveillance visits within the first week of life: the first within 48 h, followed by another on Day 6 or 7. During the surveillance visits, health staff are required to (1) educate the mother and other caregivers about thermal care, hygienic cord care and exclusive breastfeeding for the baby and early warning signs of maternal and neonatal illness and prompt care-seeking if present; (2) identify and treat sick newborns, including referral to higher level care if needed; and (3) ensure provision of early immunizations [Bacillus Calmette-Guérin (BCG) and oral polio vaccines], screening for sickle-cell anaemia and treatment to prevent transmission of HIV if applicable (Ministry of Health Ghana 2009).

Intervention

We used a QI approach to improve access to intra-partum and early PNC in a networked group of health facilities, otherwise known as an 'Improvement Collaborative' (IC) (Institute for Healthcare Improvement 2003), as the first phase of a national QI project (Twum-Danso *et al.* 2012); other components of the QI project focused on antenatal care and care of children under-5. In this first phase of the national project, QI teams from each of the 27 health facilities tested the new GHS early PNC policy over a 10-month period (October 2008 to July 2009) in addition to the other components of the project. They did this with technical support from the three DHMTs and three project staff members skilled in QI. As part of this test, the project staff, the DHMTs and the QI teams jointly developed a checklist to assist midwives and nurses in screening for high-risk conditions in the antenatal and perinatal periods. As the objective of the PNC intervention was to test the feasibility of the implementation of the new policy within an existing national MNCH programme, the design did not include a comparison group of facilities that did not receive the QI interventions.

As part of the IC design, the QI teams met in district-based groups every 3–4 months at structured 2-day workshops called 'Learning Sessions'. There, they learned methods to identify process failures within their own health systems, develop and test local ideas to improve processes of care (change ideas) (Langley 2009), measure whether these changes were leading to improvement, and share their progress with their peers. Further details of the Learning Sessions and the intervening site visits for coaching, mentoring, feedback and technical support for change idea generation, local data analysis and interpretation, and co-ordination with district priorities are described elsewhere (Twum-Danso *et al.* 2012). A 'change idea' was defined as any new idea directed at improving an activity or process in the continuum of maternal and child care. No funds were provided by the project to district or facility staff for the testing or implementation of change ideas. Rather, these change ideas were primarily a redesign of existing processes for health education, community engagement, transportation, customer service and supervision. Where funds were needed for fuel or other supplies, they were re-allocated from existing budgets at the DHMT based on a priority-setting exercise between the DHMT and health-facility managers.

Data collection

In the absence of an early PNC policy and a standardized PNC register, previous data collection tools for PNC had been highly variable in format and content: plain notebooks in which the health staff ruled lines to create rows for each patient and columns for each indicator of interest. For the test of the new early PNC policy, the project staff, together with the participating health staff, developed a standardized register to capture demographic details, vital signs and responses to key screening questions for both mother and neonate. All health staff were trained to use the PNC registers during a Learning Session.

Point-of-care data were captured initially in the PNC register by the midwife or community health nurse attending to the post-partum woman and neonate in health facilities or during home visits. These data were then summarized on a monthly basis by the project staff during site visits by reviewing the PNC registers together with the health staff. Any discrepancies in the data were immediately resolved at source before the project staff documented the data in their notes. Upon their return to the project office, the data were entered into an electronic database and aggregated at the level of the entire IC.

The indicators monitored were skilled delivery, PNC on Day 1 or 2, PNC on Day 6 or 7 and institutional neonatal death rate; operational definitions are provided in Table 1. The PNC visit on Day 6 or 7 included neonates who were assessed at home by health staff or community health volunteers (CHVs) trained by health staff to detect early warning signs of neonatal ill health. Sick infants and their parents were referred immediately to health facilities and health staff were notified by telephone or bicycle. These CHVs were part of an existing GHS's community-based surveillance system responsible for reporting births, deaths and notifiable diseases to the health staff on a monthly basis. The ratio of CHVs to population is typically 1 to 500. Given that infant births and deaths occurring in the communities were not reliably reported by the CHVs, these data were not included in this analysis. Facility-based births were reliably recorded in delivery registers. Unskilled deliveries were determined with a fair degree of certainty during the first immunization visit and recorded in the Routine Health Information System (RHIS) since coverage of BCG immunization in Ghana, which occurs in the first month of life, exceeds 95% (ref:http://www.who.int/immunization_monitoring/data/gha.pdf). Facility-based neonatal mortality rates were calculated as facility deaths per total deliveries (both skilled and unskilled).

For the early PNC intervention, baseline data were collected retrospectively from primary sources (i.e. PNC registers) at the health facility level for the 9-month period (January 2008 to September 2008) prior to the start of the intervention in October 2008 and for 25 months thereafter. Interventions for skilled delivery preceded the early PNC intervention by 3 months (July vs October 2008). Baseline data for skilled delivery and facility-based neonatal deaths were collected from the midwifery monthly report at the facility level retrospectively for 6 months (January 2008 to June 2008), and the post-intervention data were collected for the subsequent 35-month period.

Data analysis

Both coverage and outcome data were analysed using an interrupted time-series design (Biglan *et al.* 2000; Benneyan *et al.* 2003). Since the PNC intervention began at various points during the month of October 2008, we included data for the 24-month period from November 2008 to October 2010 for the post-intervention period. For skilled delivery, the post-intervention period started with the launch of the project in July 2008.

Ethics

No institutional review board approval was required for this QI intervention since our goal was to test the feasibility of implementation of a national policy for which the scientific evidence of safety, efficacy and effectiveness had already been demonstrated. Furthermore, we used routinely collected aggregate de-identified data on births, deaths and health services delivered for the analysis.

Results

In total, 16 different change ideas to improve skilled delivery coverage were developed and tested over a 12-month period, while for early PNC, 10 different change ideas were developed and tested over a 10-month period. Three Learning Sessions were held 3–4 months apart in the Catholic Diocese and each of the three districts during the 10 months of testing early PNC change ideas. The average number of site visits per month during this period was 23, corresponding to 0.9 visits per facility-based QI team.

There was no improvement in skilled delivery utilization until a year after the start of QI interventions targeted at this part of the continuum of care. Skilled delivery then increased from a mean of 56% to 82% over 23 months (Table 1 and Figure 1).

During the first 12-month period following the introduction of the PNC intervention, there was a 3-fold increase in PNC provided during the first 48 h—from 14.7% to 44.5%—followed by a further increase to 71.4% during the second 12-month period (Table 1 and Figure 2a). For the follow-up PNC on Day 6 or 7, there was an increase from 0% to 27.5% (range: 21.7–43.4%) during the first 12-month period following the intervention, with a further increase to a mean of 52.5% (range: 42.0–61.2%) in the final 12 months (Table 1 and Figure 2b). All-cause mortality rates for neonates admitted to health

Table 1 Pre- and post-intervention results on utilization of skilled delivery and early post-natal care

Indicator	Indicator elements	Time period							
		Pre-intervention		1–12 months post-intervention		13–24 months post-intervention		25–36 months post-intervention	
		Mean	%	Mean	%	Mean	%	Mean	%
Skilled delivery[a]	Number of skilled deliveries	316	56	366	56	396	70	435	82
	Total number of deliveries	591		642		548		516	
PNC on Day 1 or 2[b]	Number of neonates receiving PNC within 2 days of birth	76.9	14.7	300.6	44.5	357.3	71.4		
	Total number of neonates registering for PNC	523		620.7		497.2			
PNC on Day 6 or 7[b]	Number of neonates receiving follow-up PNC on Day 6 or 7 after birth	0.2	0	191.3	27.5	265.5	52.5		
	Total number of neonates registering for PNC	523		620.7		497.2			

Notes: [a]Pre-intervention period (i.e. baseline) was January 2008 to June 2008.
[b]Pre-intervention period (i.e. baseline) was January 2008 to September 2008.
mths = months; no. = number; PNC = post-natal care.

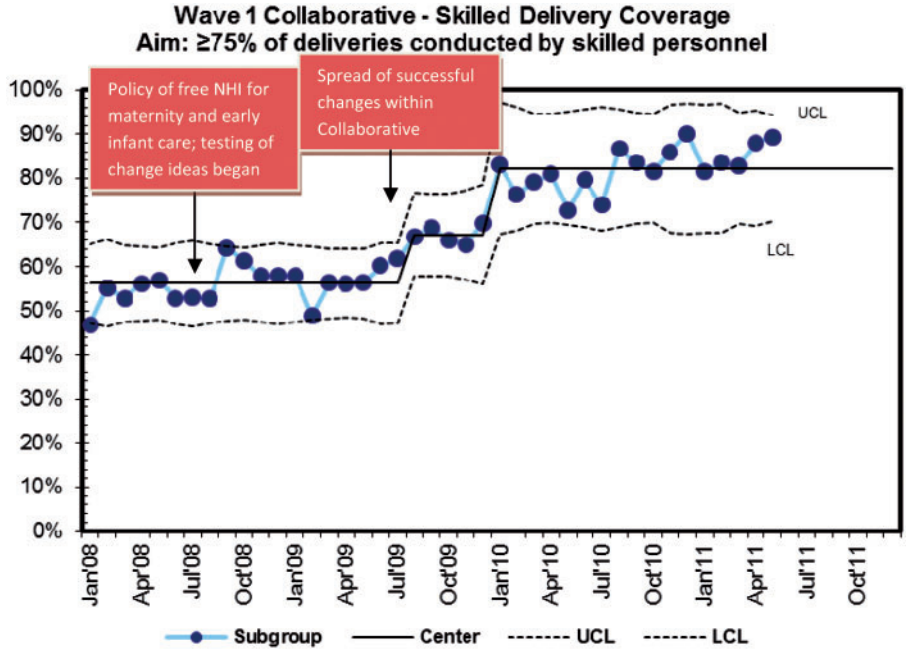

Figure 1 Skilled delivery utilization in the catchment area of the health facilities participating in the first wave of the IC from January 2008 to May 2011

facilities was unchanged, with a mean of 6.7 deaths per 1000 deliveries before and after the intervention; the mean number of deaths per month over the period was three (data not shown). The number of cases of early warning signs of illness detected in post-partum women and neonates during the first week of life and referred to health facilities is not captured by the RHIS.

In August 2009, we aggregated time-series data for health facilities that had tested the same change idea, and used run chart rules (Perla *et al.* 2011) to determine whether or not the change ideas had resulted in a significant improvement in PNC attendance within 48 h of birth and follow-up care on Day 6 or 7. The most effective change ideas were then assembled into a detailed guide ('Change Package', Table 2), which was then promoted to the clinics and hospitals of the initial IC (Wave 1) which had not yet shown significant improvement as well as to facilities in the 35 additional districts in the three northern regions.

Discussion

We have demonstrated the technical feasibility of implementation and rapid scale-up of an evidence-based policy for early PNC across three large health administrative regions in a low-income, rural context in Ghana. This was achieved through a phased scale-up approach that used small-scale, rapid-cycle innovation and testing of locally derived change ideas by frontline health providers with technical support from their DHMTs and external QI experts, followed by large-scale adoption and adaptation of the most effective ideas through multi-district learning networks. This rapid implementation occurred in spite of substantial geographical, infrastructural and sociocultural challenges and limited human resources in health facilities.

By using rapid cycle testing and learning networks to explicitly harness contextual knowledge and local learning to improve the implementation of the policy during both the innovation and scale-up phases, our QI approach took into account the complexity of a health system as a technical, social and political entity with a unique organizational structure, history and culture embedded in the larger societal culture which varies across the country. This multidimensional QI approach is consistent with the recent calls for the design, implementation and evaluation of public health programmes in resource-poor settings to be more mindful of context and to view health systems as complex adaptive systems with non-linear outcomes (Victora *et al.* 2005; English *et al.* 2009; Bryce *et al.* 2010; Paina and Peters 2012; Svoronos and Mate 2011).

The 3-fold increase in PNC utilization on Day 1 or 2 soon after the early PNC policy was introduced was not due to an increase in skilled delivery utilization (which was not changed during this time). This change in PNC attendance demonstrates the willingness of the health providers and the communities they serve to substantially redesign their processes and expectations for management of the immediate post-partum period, including detaining women and newborns in health facilities for 24 h for additional monitoring and conducting home visits for those who chose to return home earlier or who live close to the health facility. We were not able to determine the proportion of these first PNC visits that occurred at the facility or in the community as the PNC reporting requirement for the RHIS did not distinguish them. The additional increase to 71% in the second 12-month period fell short of the IC's aim of 85% but suggests continued improvement within the IC clinics once the 'change package' was available. This second phase of

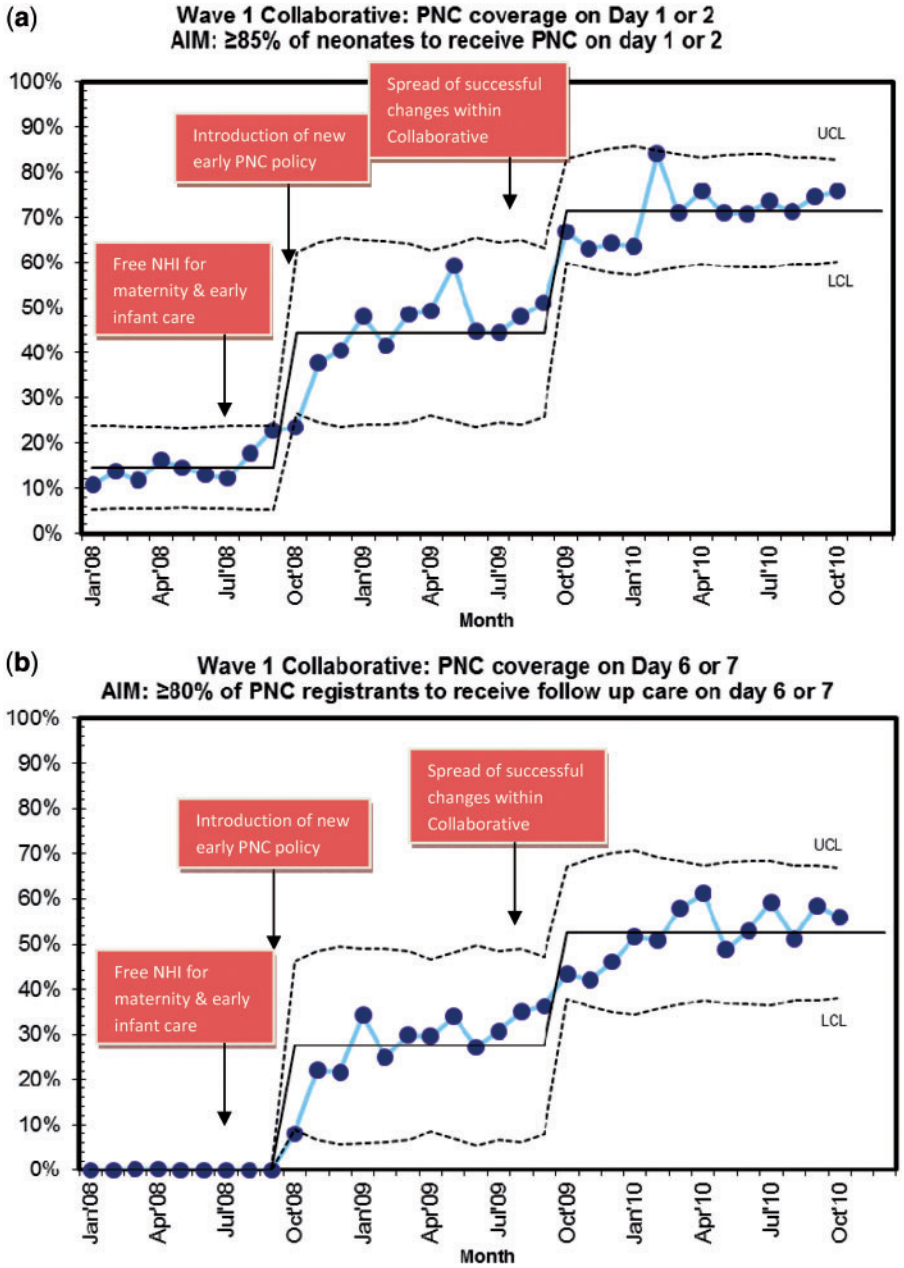

Figure 2 (a) Post-natal care utilization on Day 1 or 2 of life in the catchment area of the health facilities participating in the first wave of the IC from January 2008 to October 2010. (b) Follow-up post-natal care utilization on Day 6 or 7 of life in the catchment area of the health facilities participating in the first wave of the IC from January 2008 to October 2010

increase in early PNC utilization also coincides with an increase in the mean skilled delivery utilization to above 70% from an initial low of 56%, suggesting that some of the subsequent increase in PNC may have been due to increased opportunities for detaining more newborns for observation in the first 24 h of life, and identifying more newborns for follow-up. The delay in improvement in skilled delivery may be attributable to delay in finding the most appropriate change ideas to improve demand and/or supply of skilled delivery in particular local contexts, unreliable implementation of new change ideas, failure to sustain successful change ideas, slow increase in awareness of the free NHI for maternity and early infant care, and administrative bottlenecks in implementing the free NHI during its first year. The decrease in the number of deliveries and PNC registrants in the second 12-month period following the introduction of the intervention is surprising and unexplainable to date.

The sharp increase in follow-up PNC utilization on Day 6 or 7 from a mean of 0% to 22% within a month of introduction of the new early PNC policy and further increase to more than 50% in less than 18 months of introduction of the policy (Figure 2b) again suggests willingness of the health providers

Table 2 Change package (change ideas determined to be most effective in increasing early PNC utilization in the catchment area of the health facilities participating in the first wave of the IC)

No.	Change idea(s)	Detailed 'how-to' guide
PNC on Day 1 or 2		
A	*If facility skilled delivery*—detain for ≥24 h, if possible. If not, discharge after minimum of 6 h and follow up on Day 2 with facility or home visit	(i) Detain all post-partum mothers for observation ≥24 h during which mother and child are monitored for any post-partum and/or post-natal danger signs (ii) If no capacity to detain post-partum mothers for 24 h, discharge after a minimum of 6 h if mother and child are both healthy: (a) For those from nearby communities, encourage mother to return with baby the next day for follow-up post-partum care and PNC. If she states that she is unable to return, make an appointment for home visit on Day 2 (b) For those from distant communities: • Refer to nearest health centre/CHPS zone for post-partum care and PNC on Day 2 • Contact health staff at referral point by telephone to notify them of referral and ask them to do home visit if woman fails to show up
B	*If domiciliary skilled delivery*—follow up on Day 2 with facility or home visit	(i) If mother and child are healthy after delivery and immediate PNC: (a) If mother lives in nearby community, encourage her to return to facility the next day for follow-up post-partum care and PNC. If she states that she is unable to return, make an appointment for home visit on Day 2 (b) If mother lives in distant community, conduct follow-up home visit on Day 2 (ii) If post-partum and/or post-natal danger signs are identified immediately after delivery promptly refer and arrange transport to health facility for additional care
C	*If unskilled delivery*—encourage information flow between family members and volunteers, and health staff	(i) Ask family members, CBVs and TBAs to notify health staff immediately by mobile phone, bicycle or motorbike (ii) For post-partum mothers from nearby communities, ask family members, CBVs or TBAs to encourage woman to come to facility for post-partum and PNC on Day 1 if possible. If not possible, follow up with home visit on Day 1 or 2 (iii) For post-partum mothers from distant communities, proceed to woman's home on Day 1 or 2 to provide post-partum and PNC.

(continued)

Table 2 Continued

No.	Change idea(s)	Detailed 'how-to' guide
PNC on Day 6 or 7		
A	During Day 1 or 2 visit, make appointment for Day 6 or 7 visit at facility or home. Use reminder systems at community, clinic/hospital to improve reliability	(i) During first PNC visit, give appointment date for second PNC and post-partum care that would occur on Day 6 of baby's life (ii) Encourage mothers to return on Day 6 for follow-up post-partum and PNC. If she fails to show up on Day 6, follow up with home visit on Day 7 (iii) Use *reminder systems at clinic/hospital* to improve reliability such as: (a) Write appointment dates in pencil in the PNC register to alert staff of pending PNC on a particular date so they can follow up with home visit if mother fails to show (b) Trace post-partum mothers who do not attend on Day 6 to their homes to provide PNC and post-partum care on Day 7 (c) Write dates, names and addresses of expected mothers for second PNC during particular week and post on notice board as reminder to health staff to follow up on the appropriate dates (iv) Use *reminder systems at the community level* to improve reliability such as: (a) Write expected date of second PNC visit on maternal health record card before discharge and ask mother to show it to her family members and CBVs when she get home so they can (read it for her if she is illiterate and) remind her when the day arrives (b) Ask CBVs to follow up with home visit on Day 4 to ensure mother and child are doing well, and to remind mother of date of second PNC visit (c) Train CBVs to detect most common maternal or neonatal danger signs and refer promptly to the clinic
B	If woman lives in *different sub-district or distant community within CHPS zone*, refer to other sub-district or CHO for Day 6 or 7 visit. Contact CHO to follow up if no show	(i) Refer women who live in different sub-district or distant community within CHPS zone to seek second PNC on Day 6 at the closer facility based on address (ii) Contact sub-district or CHPS zone staff to inform them of the referral and provide them with name and address of mother in case of default (iii) (iii)Ask sub-district or CHPS zone to conduct follow-up visit on Day 7 for mothers who fail to show up on Day 6
C	If woman lives in *distant community without CHO* and return facility visit not possible *and* health staff cannot do home visit, train IMCI volunteers to provide Day 6 or 7 care	(i) Train IMCI volunteers to provide PNC on Day 6 or 7 as well as detect the most common maternal or neonatal danger signs and promptly refer to clinic

Note: CBV = community-based volunteer; CHO = community health officer; CHPS = community-based health and planning services; IMCI = integrated management of childhood illnesses; PNC = post-natal care; TBA: traditional birth attendant.

and the communities to 'actualize' the new policy once its merits had been explained to them and they were encouraged to develop their own local solutions. This represents a merging of demand- and supply-side interventions to achieve solutions that address the needs of both community and health staff. For example, structuring home visits for follow-up PNC on Day 6 or 7 required a substantial change in staff scheduling and fuel allocations for community health nurses, who were previously used to visiting communities only once a month for immunizations and health education. Likewise, families agreeing to let post-partum women and newborns leave the house for a health visit or have an outsider in their home before a newborn had been named or officially presented to the outside world (termed locally as having been 'outdoored') required changes in community cultural practices. Where previously it was taboo for a post-partum woman and newborn to leave the house for the first few weeks after birth for fear of evil spirits causing harm to the baby, communities were sufficiently convinced of the need for early PNC to change their practices. This represents a strengthening of the partnership between health providers and the communities they serve. PNC reporting requirements did not differentiate between the proportion of second PNC visit that was achieved through home visits vs the return of mother and child to the health facility.

The correlation between the timing of the deliberate spread of the 'change package' within the initial IC and the observed second phase of improvement in both first and second PNC visits from October 2009 onwards (Figure 2a and b) demonstrates the importance of peer-to-peer learning and sharing to acceleration of improvement across a network. This rapid uptake of the new policy is consistent with Everett Rogers' model of the diffusion of innovations, which has been applied in multiple sectors including agriculture and health (Rogers 2003). Analysis of the determinants of QI team performance is ongoing and will be published elsewhere. More work is needed to define factors that can further accelerate the adoption of innovations in process improvements in health to make the achievement of MDG 4 in Ghana and other resource-constrained settings more likely.

The pace of implementing this new early PNC policy on a large scale (i.e. full implementation in three complete health administrative regions in 3 years) is rapid compared with scale-up efforts of similar national health policies and programmes in Ghana and other resource-poor settings (Nyonator *et al.* 2005; Bryce *et al.* 2010; Boschi-Pinto *et al.* 2009). The reasons for this success are likely related to the flexibility that the QI approach affords frontline providers in tailoring the implementation of the intervention to their local context, the emphasis on learning from local data and adapting the intervention on an iterative basis, and the regular monitoring and coaching of the frontline providers by the DHMTs and project staff. Further monitoring is needed to determine the sustainability and impact of this QI approach for the PNC policy and the implementation of other primary health-care interventions at the district level in the three regions and in the final scale-up of the project to the rest of the country.

One important limitation of this work is the delay in integrating the data requirements to monitor the impact of this policy into the RHIS of the GHS. Throughout the intervention period, we were unable to access data on community-based neonatal deaths because the community-based surveillance system aggregated all infant deaths and due to the unreliability of reporting of deaths in the community. This limited our ability to determine the effectiveness of a number of change ideas, which were directed at changes in community outreach and community behaviour rather than changes at the facilities. This limitation was compounded by the fact that in the rural areas, care-seeking for neonatal illnesses in health facilities is uncommon (Bazzano *et al.* 2008) and facility-based neonatal death rates were already low at baseline (6.7 per 1000 skilled deliveries). Thus, our power to detect an improvement at that level of the health system alone was limited. Furthermore, our ability to monitor utilization of the early PNC intervention at scale (nearly 600 facilities) was also hampered by a delay in the inclusion of key indicators reflecting this activity in the reporting forms that the health providers submit to the DHMTs every month. During the innovation and testing phase of the policy, we collected these data manually from the PNC registers at each of the 27 health facilities. However, substantial progress was made in development of new process and outcome indicators during the course of this project; the RHIS now includes the PNC utilization indicators in its reporting requirements, and the registers of the community-based surveillance system were modified to distinguish neonatal from post-neonatal infant deaths. Improving the reliability of reporting the community-based surveillance data will continue to be a focus of intervention.

A second limitation of this study was the lack of data on referrals for neonatal illnesses, neonatal morbidity cases and case fatality rates of the most common causes of neonatal deaths in the RHIS. These data could have helped us to determine an intermediate outcome effect of the early PNC policy, since deaths are rarer than illnesses. More visibility of the neonate in the RHIS is required to ensure the needed focus on addressing illnesses that are unique to this vulnerable population.

A third limitation of this study is the use of PNC registrants as the denominator for utilization rather than live births because the latter were not available at the population level. This may have led to a higher apparent proportion of PNC attendance due to the exclusion from the denominator of newborns who were delivered at home and whose families did not seek any health care (including BCG immunization) within the first 4 weeks of life. This sub-population is likely to be small, as PNC utilization for any time between Day 1 and Day 41 prior to introduction of the new early PNC policy was 82% for two of the three regions involved in this work (Ghana Statistical Service *et al.* 2009) and BCG coverage exceeds 95% (ref: http://www.who.int/immunization_monitoring/data/gha.pdf).

Another limitation could be the potential overestimate of post-intervention data relative to pre-intervention due to better documentation after the new PNC policy and the QI intervention were introduced; this is a limitation of all QI efforts in 'real-life' health systems that rely on the RHIS. This could have had a small effect on the PNC encounter on Day 1 or 2, but it would not have affected the visit on Day 6 or 7 since that encounter was not required in previous policies and thus was

rarely happening as reflected in the baseline data (Figure 2b). The risk of health providers reporting inflated numbers of women and children reached was reduced by validating reported data with data recorded in the clinical registers during the first phase of the work.

Our findings would have been strengthened by the presence of counterfactual districts that had the policy introduced without the use of QI methods. The presence of a comparator group would have helped to explain whether some of the unexpected findings (the apparent fall in total number of births) were isolated or more widespread phenomena. However, this was not feasible as this test of the new policy preceded formal adoption and national rollout of the policy. Historically, uptake of new policies is slow. Thus, the rapid uptake of the new PNC policy, resulting within a few months in very high PNC attendance, provides greater confidence that the QI methods were helpful in introducing the policy and scaling it up. To reduce neonatal mortality rates, more emphasis needs to be placed on increasing the reliable use of partographs to monitor labour and improving curative care for newborns including neonatal resuscitation, adherence to newborn sepsis protocols and thermal care for low-birth-weight babies. Furthermore, efforts will need to be directed to increasing the number of skilled birth attendants, improving logistics to ensure adequate fuel for home visits and supplies, and improving health infrastructure such as increased number of beds in maternity wards and availability of bathing and catering facilities for post-partum women in health facilities. Access to facility-based newborn morbidity data and community-based newborn mortality data will greatly enhance assessment of the effectiveness of the policy. Finally, increasing skilled delivery and early PNC will require improvements in non-health infrastructure such as roads, bridges, transportation, girl child education and empowerment of women.

This work was designed with scale-up as a goal. Thus, in September 2009, the change package was spread actively to the remaining 35 districts in northern Ghana. By October 2011, the policy was being implemented by 576 health facilities serving a population of approximately five million. To confirm that this intervention is truly feasible within the resource constraints of the Ghanaian health system, further monitoring is needed to determine the effectiveness, cost effectiveness and sustainability of the PNC policy at large scale. Since we are tracking a range of activities across the spectrum of maternal and child health, we will be able to monitor whether the decisions made by managers to prioritize funding of PNC interventions will affect performance in other areas. We will monitor how well the scale-up in the north is translated to increased PNC utilization and reduced neonatal mortality, how well change ideas from the north are adopted and adapted to new contexts in the south as the project scales up further, and how new change ideas are developed over time.

Conclusion

We have demonstrated the utility of a QI approach in testing, implementing and scaling up a national health policy for early PNC in a resource-constrained environment. Following an innovation phase, we rapidly scaled up, by more than 10-fold, the most effective implementation strategies to provide early access to PNC for the most-deprived regions of Ghana. Our emphasis on empowering frontline health providers to operationalize the policy in their local context and share their most effective changes with their peers in a collaborative learning network helped to accelerate the large-scale implementation of the policy over 3 years. This work could provide a model for introducing, testing and rapidly scaling up other national health policies to accelerate the achievement of the MDG in Ghana and other resource-poor settings.

Authors' roles

N.A.Y.T.-D. led the design and implementation of the QI intervention and wrote the first draft of the manuscript. I.N.D., I.A. A.-E., A.A. and E.K. implemented and monitored the QI intervention through technical support to the QI teams and collection of data from the health facilities. R.O.B. and S.A. were responsible for data analysis and reporting. P.B., F.B. and C.K. implemented and monitored the early PNC policy in their respective districts. P.B. also contributed to the writing of the manuscript. I.S.-M. developed the national early PNC policy, and contributed to the design of the QI intervention and writing of the manuscript. P.M.B. contributed to the design, implementation and monitoring of the QI intervention and writing of the manuscript. All authors reviewed and approved the final manuscript.

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Conflict of interest

None declared.

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