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Neonatal mortality in rural northern Ghana and the three delays model: are we focusing on the right delays?

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Abstract

OBJECTIVE The Three Delays Model outlines, three common delays that lead to poor newborn outcomes: (i) recognising symptoms and deciding to seek care; (ii) getting to care and; (iii) receiving timely, high-quality care. We gathered data for all newborn deaths within four districts in Ghana to explore how well the Three Delays Model explains outcomes.

METHODS In this cross-sectional, observational study, trained field workers conducted verbal and social autopsies with the closest surviving relative (typically mothers) of all neonatal deaths across four districts in northern Ghana from September 2015 until April 2017. Data were collected using Survey CTO and analysed using StataSE 15.0. Frequencies and descriptive statistics were calculated for key variables.

RESULTS 247 newborn deaths were identified. Nearly 77% (190) of newborns who died were born at a health facility, and 48.9% (93) of those who died before discharge. Of the 149 newborns who were discharged or born at home, 71.8% (107) sought care at a facility for illness, and 72.9% ($N = 78$) of those did so within the same day of illness recognition. Of the 83 respondents who arranged for transportation, 82% (68) did so within 1 h. Newborns received prompt care but insufficient interventions – 25% or fewer received IV fluids, oral medications, antibiotics or oxygen.

CONCLUSIONS These data suggest that women are following recommendations for safe delivery and prompt care-seeking. In rural northern Ghana, behaviour change interventions focused on mothers and families may not be as pressing as interventions focused on the Third Delay – obtaining timely, high-quality care.

keywords Ghana, social autopsy, verbal autopsy, three delays, neonatal mortality, healthcare quality

Sustainable Development Goals (SDGs): Good health and well-being, end preventable deaths of newborns and under-fives; gender equality

Introduction

Many low- and middle-income countries (LMICs) continue to struggle with high neonatal mortality rates. Ghana – now classified as a lower-middle-income country – has made marked improvements in many health indicators, but has not realised significant gains in newborn survival. According to the 2014 Ghana Demographic and Health Survey, nation-wide neonatal mortality is approximately 29 per 1000 live births, with wide variability throughout the country [1]. This rate accounts for half of all under-five childhood deaths, meaning that surviving the first month is critical to overall childhood survival [1].

Facility-based delivery [2] and rapid care-seeking for illness [3] are known to improve newborn health outcomes in LMICs. One of the most popular models to highlight common barriers to care-seeking in low-resource settings is The Three Delays Model [4]. The Three Delays Model, originally designed to explore care-seeking during obstetric emergencies, outlines the three most common points of delay that can lead to poor outcomes for mothers and their babies during childbirth. These comprise Delay 1 (delays in recognising symptoms and deciding to seek care), Delay 2 (delays in physically getting to care – typically transportation-related delays) and Delay 3 (delays in receiving timely, high-quality care upon arriving at a healthcare facility). This model has been adapted and used for newborn survival in places such as Uganda [5], Rwanda [6], Ethiopia [7], and Ghana [8].

As part of a larger study in rural northern Ghana [9], we gathered data on the demographic, delivery, and care-seeking behaviours for all newborns who died within four study districts and used social autopsy methodology to explore how well the Three Delays Model explains newborn outcomes.

Methods

Design

The PREMAND study methods are detailed at length elsewhere [9], but briefly, this was an observational, cross-sectional study that conducted social autopsy interviews with families of all newborns within four study districts who had died within the first 28 days after birth from 1 September 2015 to 30 April 2017.

Setting

This project was carried out in four districts in northern Ghana – the Kassena-Nankana Municipal, the Kassena-Nankana West, the Sissala East and the East Mamprusi districts – all of which are in regions with neonatal mortality rates higher than the national average [10]. These districts have approximately 350,000 residents with land that covers roughly 10,000 square kilometres [11]. Across the four districts, there are three hospitals, and several other lower-level healthcare facilities.

Study participants

Trained field workers from the study districts worked to identify all neonatal deaths within the community. Deaths were followed with screening interviews to determine if the death occurred within the neonatal period (first 28 days after birth). Qualifying events were further followed with a verbal and social autopsy (VASA), consisting of a semi-structured interview and an in-depth interview with the closest surviving family member, which was typically the mother.

Interview participants needed to have provided informed consent, be able to answer detailed questions about the time leading up to the death and be able to speak one of the following five languages: Mampruli, Sissali, Kasem, Nankam or English.

Instruments used

Field workers assisted the closest surviving relative (typically the mother) in responding to an extensive verbal and social autopsy (VASA) questionnaire comprised of modified existing tools from the Navrongo Health Research Centre (NHRC), the INDEPTH Network, and the Child Health Epidemiology Research Group [12, 13]. The verbal autopsy (VA) portion, developed from NHRC's standard neonatal verbal autopsy protocol, was used to determine cause of death (COD) using a panel of physician coders [14] (See below for details on cause of death determination.) The VASA included detailed questions about symptoms, symptom presentation, illness progression, and care administered, as well as social factors such as access to care and family support. In keeping with standard Verbal Autopsy methodology designed for data collection in resource-limited locations [15], survey responses and cause of death determinations were not validated against facility-based clinical data.

Data collection

Experienced field workers underwent a 10-day intensive training course with simulations and mock interviews. Field workers worked with local village chiefs to obtain permission to visit families who had experienced a neonatal death in their homes. They also obtained permission from compound heads, or the senior male in an extended family network, before approaching respondents. Visits occurred following deaths within a time interval that was deemed culturally appropriate – typically no sooner than one month after the event – and surveys were completed within 6 months of the event to minimise issues with recall. Interviews were conducted in the preferred language of the respondent (Mampruli, Sissali, Nankam, Kasem or English). Field workers consisted of 5 males and 1 female; all from the district in which data were being collected, and trained in conducting interviews. All field workers were fluent in English as well as at least one of the local languages and had experience conducting surveys prior to this study. Data were collected and entered using a hand-held tablet with the Survey CTO (Dobility, Inc; Cambridge MA) interface, allowing for remote storage of data using a cloud-based server.

Consent

None of the community leaders who were approached for permission refused entry for the field team. Although permission by the chiefs did not necessarily mean that community members had to participate in the study, no potential participants declined to participate. All completed an informed consent process with a thumbprint used in lieu of a signature by those with low literacy skills.

Matching

Although sex concordance between interviewer and respondent has been shown to be important in some contexts, NHRC has been conducting verbal and social autopsies and household surveys with predominantly male field workers in northern Ghana for 25 years without indications of data quality compromise. Thus we did not attempt to match the sex of respondents with the sex of the field worker.

Key variables

All demographic, care-seeking and clinical data were based on self-reports from family members of the deceased newborn.

A wealth-index was created using an additive scale of assets including car/truck, motorcycle, tractor, bicycle, electricity, refrigerator, television, radio, sewing machine, electric iron, ran, electric/gas stove, donkey cart, kerosene stove and personal computer. Scores ranged from 0 to 15, which were divided into 4 quartiles, with quartile 1 reflecting the fewest assets.

Cause of death (COD) was determined by two physicians who independently reviewed completed verbal and social autopsy tools to identify the most likely COD. When there was agreement between the two coders, a COD was assigned. When there was disagreement, the two physicians discussed the case to attempt to reach an agreement. In cases where consensus could not be reached, a third coder was engaged. If it was still not possible to determine a definitive COD, the COD was coded as 'undetermined'. VASA surveys and the resulting COD determination were not compared with medical records or laboratory testing, given the variability in availability of laboratory testing facilities, care-seeking to generate medical records, and availability of documentation.

The three delays were determined by the following questions:

- *Delay 1* (delays in recognising symptoms and deciding to seek care): How long did it take from noticing the first symptom to realising the baby needed help? How many days after the first symptom did you go outside the home to seek care for the baby?
- *Delay 2* (delays in physically getting to care): How much time did it take to arrange for transport? Once you were on your way, how much time did it take to get to the provider?
- *Delay 3* (delays in receiving high-quality care upon arriving at a healthcare facility): How long after you arrived at the first care provider was treatment obtained? What kind of treatment was given for the baby?

Data analysis

Data were downloaded from the Survey CTO interface (Dobility, Inc.; Cambridge, MA) in a format compatible with StataSE 15.0 (College Station, TX). Data were cleaned and formatted for analysis. Frequencies and descriptive statistics were calculated for each of the key variables.

Ethics

The ethics review boards at the Ghana Health Service (GHS-ERC: 05/01/15), the Navrongo Health Research Centre (NHRCIRB194), and the University of Michigan (HUM00093372) either exempted (UM) or approved (NHRC, GHS) the project.

Results

Table 1 describes the characteristics of deceased newborns, maternal and household factors across study districts. We identified and collected verbal and social autopsy data on 247 neonatal deaths across the four study districts.

Demographics

Of the 247 neonatal deaths, there were more male newborn deaths (58.3%; $N = 144$) than female (41.7%; $N = 103$), and nearly 80% were singleton births. The vast majority of mothers were married (91.5%; $N = 226$), and most were in monogamous marriages (64.4%; $N = 169$ monogamous; 35.6%; $N = 88$ polygamous). Maternal and paternal years of completed education were similar (3.8 ± 4.7 years maternal and 3.3 ± 5.0 years paternal education). The majority of the respondents were in the second-lowest wealth quartile (41%; $N = 102$), while roughly 25% of the respondents were in quartile 3 ($N = 65$) and quartile 4 ($N = 61$). Only 8% ($N = 20$) of respondents were in the lowest wealth quartile.

Pregnancy

Slightly less than 30% ($N = 69$) of respondents were experiencing their first delivery and the majority of deliveries were vaginal (88.3%; $N = 218$). Nearly all women attended at least one antenatal care (ANC) visit (96.0%; $N = 237$), and roughly 82% ($N = 204$) attended four or

Table 1 Characteristics of deceased newborns, maternal and household factors across study districts (n = 247)

Characteristics	Neonatal death Mean ± SD; *N* (%)
Newborn gender	
Female	103 (41.7)
Male	144 (58.3)
Singleton birth	195 (78.9)
Mother of baby was married	226 (91.5)
Marriage type	
Monogamous	169 (64.4)
Polygamous	88 (35.6)
Highest level of education completed (years)	
Maternal	3.8 ± 4.7
Paternal	3.3 ± 5.0
Household wealth quartile	
Q1 (poorest)	20 (8.1)
Q2	102 (41.1)
Q3	65 (26.3)
Q4 (least poor)	61 (24.3)
Maternal Gravida	3.5 ± 2.4
First Delivery	69 (28.6)
Vaginal Delivery	218 (88.3)
Antental Care (ANC)	
Any ANC	237 (96.0)
4 + ANC visits	204 (81.7)
Maternal symptoms during pregnancy	
Blurred Vision	96 (38.8)
Fever	96 (38.8)
Severe abdominal pain	111 (44.9)
Early/preterm labour	58 (23.5)
High blood pressure	23 (9.3)
Medications mother received at ANC (*N* = 237)	
Antimalarials	212 (89.5)
Immunisation against tetanus	201 (84.8)
Folic Acid	205 (86.5)
Dewormers	128 (54.0)
Iron supplements	201 (84.8)
Pain killers	62 (26.2)
Nothing	3 (1.3)
Herbs	12 (5.1)

more ANC visits. A number of women reported having symptoms during pregnancy, including blurred vision (39%; *N* = 96), fever (39%; (*N* = 96), severe abdominal pain (45%; *N* = 111), early/preterm labour (24%; *N* = 58), and high blood pressure (9%; *N* = 23).

Of the 237 respondents who answered questions about medications provided at ANC visits, most reported receiving antimalarials (89.5%; *N* = 212), tetanus immunisation (84.8%; *N* = 201), folic acid (86.5%; *N* = 205), dewormers (54.0%; *N* = 128), iron supplements (84.8% (*N* = 201), pain killers (26.2%; *N* = 62) and herbs (5.1%; *N* = 12). Only 1% of respondents (*N* = 3) reported getting no medications at ANC.

Table 2 describes the care sought and received for newborns from delivery through death, as well as the cause of death determined by physician reviewers.

Delivery

More than three out of four respondents (*N* = 247) delivered at the hospital or a health centre (76.9%; *N* = 190), and 4.8% (*N* = 12) delivered on the way to a facility. 18% (*N* = 45) delivered at home, and of those who provided a reason for why they delivered outside of a facility (*N* = 39), the majority (66.7%; *N* = 26) attributed their home deliveries to labour coming on too quickly. Another 38.5% (*N* = 15) stated they could not procure transportation in time, and 12.8% (*N* = 5) reported being too far away from a facility. The remaining 7.7% (*N* = 3) of women who delivered at home reported that they needed permission to seek care that they did not receive.

Place and age of death

The majority of the 247 deaths occurred at facilities (66.8%; *N* = 165), and 4.8% (*N* = 12) occurred on the way to a facility. Nearly 38% (*N* = 93) of deaths occurred in newborns who were born in facilities and never left. More than one in four newborns died at home (28.3%; *N* = 70). Figure 1 illustrates where babies were delivered and died.

Roughly one-third of deaths (33.2%; *N* = 82) occurred within 24 h of birth, and 27.9% (*N* = 69) occurred within days 1–3, and 23.9% (*N* = 59) within days 4 – 7. Only 15.0% (*N* = 37) of deaths occurred between days 8 and 28.

Illness onset and care-seeking

Ninety-three of the 190 babies (48.9%) who were born at a health facility never left, ultimately dying at the facility. 170 respondents provided data on age of illness onset, and 38.8% (*N* = 66) of newborns were sick on the day they were born. Another 27.1% (*N* = 46) fell ill within 1 to 3 days of birth. Nearly 15% (*N* = 25) had illness onset at 4–7 days post-birth and the remaining 19.4% (*N* = 33) at 8-28 days. Of the 233 respondents who answered questions about illness recognition, 84.1% (*N* = 196) realised that the baby needed help within the day of illness onset, and another 11.6% (*N* = 27) realised within 1–2 days of illness onset, and 4.3% (*N* = 10) realised three or more days after illness onset. Of those who

Table 2 Care-seeking pathway for deceased newborns across study district (N = 247)

Characteristics	Neonatal Death Mean ± SD; N (%)
Place of birth	
Hospital or health centre	190 (76.9)
On way to hospital/health centre	12 (4.9)
Home	45 (18.2)
Reason born outside facility (N = 39)	
Labour came on too quickly	26 (66.7)
No transportation	15 (38.5)
Too far away	5 (12.8)
Needed permission	3 (7.7)
Place of death	
Hospital or health centre	165 (66.8)
On way to hospital/health centre	12 (4.9)
Home	70 (28.3)
Born in hospital/health centre, never discharged	93 (37.7)
Age at death	
First 24 h	82 (33.2)
1–3 days	69 (27.9)
4–7 days	59 (23.9)
8–28 days	37 (15.0)
Age at illness onset (N = 170)	
Day of birth	66 (38.8)
1–3 days	46 (27.1)
4–7 days	25 (14.7)
8–28 days	33 (19.4)
Most common first symptom recognised	
Breathlessness	78 (31.6)
Not feeding	26 (10.5)
Fever	19 (7.7)
Fits (convulsions)	13 (5.3)
Who recognised the first symptom	
Mother of the baby	139 (56.3)
Nurse or midwife	67 (27.1)
Time to realise baby needed care (N = 233)	
Within 1 day of illness onset	196 (84.1)
1–2 days after illness onset	27 (11.6)
3 + days after illness onset	10 (4.3)
(For those discharged home/home births, N = 149) Sought care outside the home for the baby	107 (71.8)
Sought care outside the home within 1 day of illness onset (N = 107)	78 (72.9)
Sought care outside the home 1–2 days after illness onset (N = 107)	18 (16.8)
Type of care sought outside the home (N = 106) (some respondents saw providers at multiple facilities)	
Hospital	70 (66.0)
Health Centre or Clinic	41 (38.7)
CHPS compound	9 (8.5)
Traditional/religious healer	5 (4.7)
First provider seen outside the home (N = 104)	
Doctor, nurse or midwife	92 (88.5)
Medical assistant	4 (3.8)
Community health provider	5 (4.8)
Traditional healer	3 (2.8)
How baby was taken to first provider (N = 106)	
Motorcycle	67 (63.2)
On foot	21 (19.8)
Private car/taxi	6 (5.7)
Public transport	5 (4.7)
Other	7 (6.6)
Less than 1 h to arrange transport (N = 83)	68 (82.0)
Less than 1 h to get to provider (N = 104)	83 (79.8)
Less than 1 h to obtain care after arrival (N = 104)	93 (89.4)
Type of care given at first provider (N = 104)	
IV fluids	26 (25.0)
Oral medication	22 (21.5)
Antibiotics by injection	13 (12.5)
Oxygen	18 (17.3)
Provider referred baby to another place of care (N = 107)	39 (36.5)
Referred to hospital/health centre (N = 39)	39 (100.0)
Baby taken to where referred (N = 39)	32 (82.1)
Baby not taken – died before could go	5 (12.8)
Baby not take – no money	2 (5.1)
Provided second referral (N = 32)	4 (12.5)
Provided third referral (N = 4)	3 (75.0)
Babies taken for treatment outside the home (N = 107) but who ultimately died at home	25 (23.3)
Cause of death (N = 246)	
Prematurity	76 (30.7)
Sepsis	68 (27.5)
Birth Asphyxia/Birth Trauma	48 (19.4)
Congenital malformations	10 (4.0)
Other	44 (17.8)

were discharged home after delivery or had home births (N = 149), 71.8% (N = 107) sought care for illness in a facility, and of those, 72.9% (N = 78) did so on the day of illness onset. Only 4.7% (N = 5) of the 106 people who reported the type of care they sought outside of the home reported seeing a traditional/religious healer, while the rest went to some type of western health facility. 82.0% (N = 68) of the 83 respondents who reported that they needed to arrange for transport did so within 1 h, and of the 104 respondents who reported the length of time it took to reach the provider 79.8% (N = 83) arrived within 1 h.

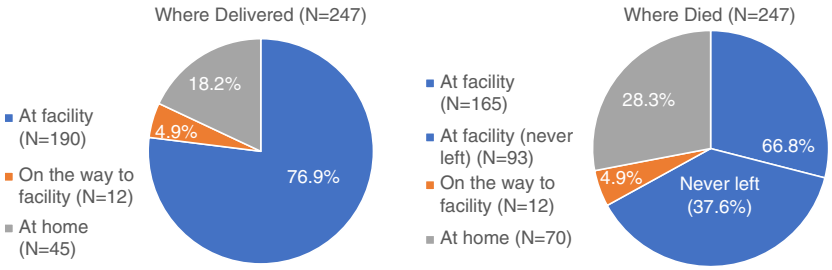

Figure 1 Where babies were delivered and died by location. [Colour figure can be viewed at wileyonlinelibrary.com]

Care provided

Nearly 90% (N = 93) (of 104 respondents who reported on care-seeking experience) received care within 1 h of arrival. At their first point of care (not including care provided at referral facilities), 25.0% (N = 26) received IV fluids, 21.5% (N = 22) received oral medications, 12.5% (N = 13) received antibiotics by injection, and 17.3% (N = 18) received oxygen. Of the 107 respondents who answered the question about referrals, more than one in three babies (36.5%; N = 39) were referred to another place of care, which was a hospital or health centre in all cases. Of the 39 babies referred, 82.1% (N = 32) were taken to the place of referral and 12.8% (N = 5) did not go to the place of referral because the baby died before they could go. Of the 32 babies who reached the first referral facility, 4 (12.5%) were referred on again to another facility (2nd referral), and 3 of those 4 (75.0%) were provided a 3rd referral. Of the babies taken for treatment outside of the home (107), 23.4% (25) ultimately died at home after seeking care.

The results are organised using the Three Delays Model in Figure 2, with the results in the lower boxes representing the major delays.

Causes of death

Of the 246 respondents for whom we have a documented cause of death, causes included prematurity (30.7%; N = 76), sepsis (27.5%; N = 68), birth asphyxia/birth trauma (19.4%; N = 48), congenital malformations (4.0%; N = 10) and other (17.8%; N = 44).

Discussion

These data suggest that, by and large, women are following recommendations regarding safe antenatal and delivery care. The vast majority of women in our sample attended 4 or more ANC visits, received prenatal medications, and gave birth in health facilities – all behaviours linked to better newborn outcomes. When looking at the events leading up to newborn deaths, 'The Three Delays' model suggests that the first two delays – that of recognising newborn illness and deciding to seek care and reaching an appropriate facility in a timely manner – are reliant upon the behaviours of mothers and families [4]. In our study, most families responded to newborn illness rapidly and appropriately. Nonetheless, all of these babies died. In addition, more than a third of the babies in our sample were born in facilities and died before referral or discharge.

These data suggest that in these four districts of rural northern Ghana, behaviour change interventions focused on mothers and families do not appear as pressing as interventions focused on the Third Delay – receiving high-quality, timely care.

Within the third delay, a clear differentiation between 'timely' and "high-quality" care is warranted. When looking at the care neonates received from health facilities, care appeared timely – with nearly 90% of respondents reporting that they received care within 1 h of arrival. However, in response to severe illness that ultimately led to death, respondents reported that at their first point of care only 1 in 4 were given IV fluids, and less than that were given oral medications, antibiotics by injection, or oxygen. This is among a sample where nearly 1 in 3 babies were premature, more than 1 in 4 had sepsis, and nearly 1 in 5 had birth asphyxia/birth trauma – all diagnoses meriting medical intervention. Nearly half of 190 babies who were delivered in a health facility died before leaving it. Of the respondents who later sought care in facilities for their ill babies, nearly 1 in 4 lost their child at home after receiving care.

A study by Kaselitz et al. (2019) determined that adequate basic (BEMONC) and comprehensive emergency obstetric and neonatal care (CEMONC) within these study districts are lacking [16]. Only 6% of facilities can provide BEMONC, and only 3% can provide CEMONC. 7% of facilities were staffed by one or more physicians, and only half by one or more midwives. This may

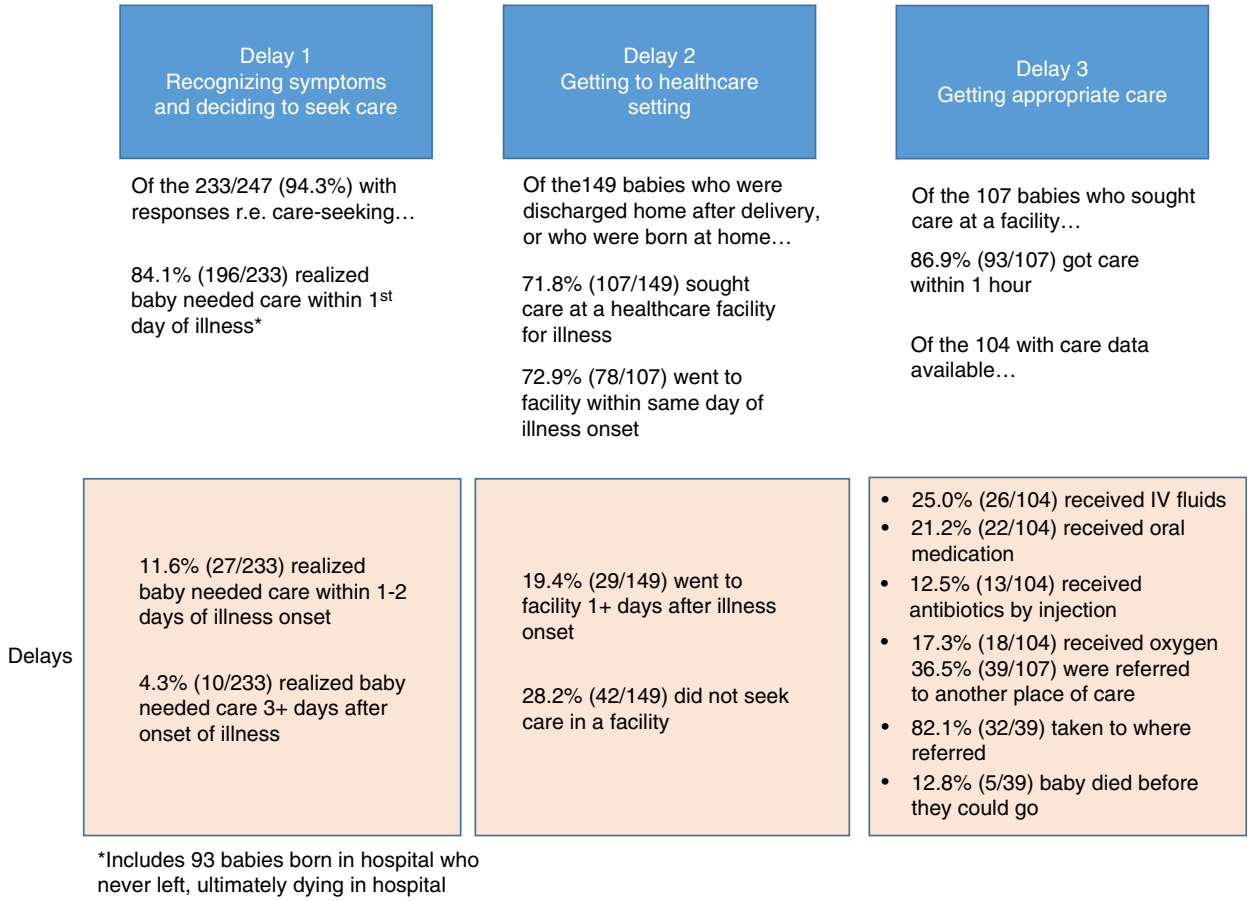

Figure 2 Care-seeking for newborn illness using the three delays model in rural Northern Ghana. [Colour figure can be viewed at wileyonlinelibrary.com]

explain the low levels of medical intervention provided to these neonates.

Chou et al. (2019) conducted a modelling study to estimate the global impact of poor quality of care on neonatal and maternal outcomes in 81 low- and middle-income countries and determined that closing the quality gap in care would result in a mortality rate decline of 21–32% [17]. Chou et al. also determined that interventions provided at or around the time of childbirth prove to be the most critical for mortality outcomes – accounting for 64% of the impact.

While our data – self-reported by the families of newborns who died – did not include independent validation of the clinical care provided, a shift in attention may be warranted if newborn outcomes are to be improved. Much of the narrative around maternal and neonatal death has been focused on behaviour change on the part of the mothers and families – more ANC attendance, more facility delivery, and/or quicker or more appropriate response to illness. We found the behaviour of mothers and family members to be largely in line with the health behaviours recommended to improve neonatal outcomes, which leads to the third delay –issues of quality of care. Quality must include improved access to necessary equipment and therapeutics to provide adequate BEMONC and CEMONC – which may be the next most important area for study and improvement in neonatal survival in Ghana.

Goodman et al. (2018) – as part of a group dedicated to promoting safe childbirth worldwide – implemented various programs to address quality of care in Ghana, with a publication titled 'Addressing the third delay: implementing a novel obstetric triage system in Ghana' [18]. This publication and others from this group address issues related to neonatal mortality, including improved triage to reduce wait times [18], and hand hygiene to reduce infection [19], among other efforts to improve healthcare quality. Their work, while critically important,

has yet to reach the rural north, where this research was conducted. Future efforts directed at measurable, sustainable quality improvement in health centres and district hospitals throughout Ghana's rural districts are warranted.

This study has several limitations. First, all data are from self-reports, and it is possible that respondents may have provided answers which they believed would reflect on them favourably. It is also possible that respondent's under-estimated clinical interventions because they were not aware of what was happening with their baby's care. Nonetheless, we believe our data make a strong argument for an increased focus on quality of care as an important next step to improving newborn outcomes. Another limitation of this study is that we cannot determine from verbal and social autopsy data whether these neonatal outcomes were a result of deficiencies in care or severity of illness – would these babies have died regardless of care quality or resources? Evidence by Chou et al. (2019) on the influence of care quality on outcomes [17] would suggest otherwise, but this only further emphasises the need for more studies on the quality of care on neonatal outcomes in Ghana.

This study also has several notable strengths with important implications. First, it is a comprehensive geographic census of newborn deaths in rural northern Ghana that covers four districts in three administrative regions in the rural north. Trained fieldworkers visited every remote village in their districts, identifying newborn deaths that would not otherwise have been counted in official statistics. Thus, we are confident that our findings reflect more than those babies who were born in facilities, typically the source of other assessments of neonatal mortality. While our study was not designed to determine neonatal mortality rates (given small population sizes and inconsistent denominators), it does illustrate that even babies born at home are often brought to facilities for care when illness is recognised – some being discharged back home to die. Our study also illustrates how successfully families have internalised the message regarding seeking antenatal care, delivering in a facility, and getting to the facility when a newborn is sick. From a public health standpoint, our study demonstrates an enormous success in Ghana: Families know to seek care for both pregnant women and their newborns. However, our study suggests that more work is needed to ensure that women and their newborns receive high-quality, timely care.

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