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Competence of health workers in emergency obstetric care: An assessment using clinical vignettes in Brong Ahafo region, Ghana.

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ABSTRACT

Objective: To assess health worker competence in emergency obstetric care using clinical vignettes in seven districts of Brong Ahafo region in Ghana; to link competence to availability of infrastructure in facilities, and to average annual delivery workload in facilities.

Design: Cross-sectional Health Facility Assessment, linked to population-based surveillance data.

Participants: Most experienced delivery care providers in 64 delivery facilities.

Main outcome measures: Vignette score by cadre of delivery care provider and by type of facility; comparison of respondent competence in vignette actions with availability of relevant drugs and equipment; average annual workload per skilled birth attendant in each facility, and the association of vignette competence with average workload.

Results: The overall vignette scores were low, and differed significantly by respondent cadre ranging from the highest average scores achieved by doctors (a median of 70% correct) and midwives (45% correct) to other workers such as health assistants and health extension workers (20% correct) (p<0.001). Competence varied significantly by facility type: Hospital respondents, who were mainly doctors and midwives, achieved highest scores (70% correct) and clinic respondents scored lowest (30% correct). Comparison of available drugs and equipment with reported vignette actions highlighted a lack of inexpensive key infrastructure items and, more often, lack of competence to use items in clinical situations. The average annual workload was very unevenly distributed among facilities, ranging from 0 to 184 deliveries per skilled birth attendant; higher workload was associated with higher vignette scores.

Conclusion: Competence might limit clinical practice even more than lack of relevant drugs and equipment. Cadres other than midwives and doctors might not be able to diagnose and manage delivery complications. Checking clinical competence through vignettes in addition to checklist items could contribute to a more comprehensive approach to evaluate quality of care.

Trial registration: http://clinicaltrials.gov NCT00623337.

RESEARCH SUMMARY

Strengths and limitations of this study

- We used clinical vignettes to assess health worker competence in rural Ghana, choosing two major causes of maternal mortality that independently working delivery care professionals should be able to diagnose and manage.

- While not nationally of longitudinally representative, our health facility assessment included all 64 delivery facilities in seven districts of Brong Ahafo region and captured the best competence available at the time of interview.

- Despite limited sample size and risk of social desirability bias in vignettes, we were able to clearly identify serious shortcomings in health worker competence in the area.

- Available surveillance data in the area allowed us to estimate births per facility to study the association between competence and workload.

- Vignettes can be used to identify poorly performing health worker cadres and to evaluate whether health worker practice is deficient due to infrastructure or competence.

INTRODUCTION

Skilled birth attendants are crucial to reducing the 289,000 maternal deaths, 2.8 million neonatal deaths and 2.6 million stillbirths that still occur every year.[1-4] Shortage of midwives, especially in remote locations, has led to training of health care professionals other than midwives to manage deliveries.[5] Presence of a skilled attendant at birth is one of the main indicators of progress towards improving outcomes related to pregnancy and childbirth, however, the approach of increasing coverage with birth attendants without assessing their skills has been criticized for ignoring quality.[6]

Measuring quality of care is challenging because quality is a multidimensional concept without a universal definition.[7, 8] Quality of emergency obstetric care in low-and middle-income settings is often evaluated with signal functions that indicate the capacity of a facility to perform certain life-saving interventions.[9] Usually, performance of a signal function within the past three months is verified using patient chart abstracts. Facilities performing a set of six basic signal functions are classified as providing basic emergency obstetric care (BEmOC), and facilities performing emergency surgery (e.g. caesarean section) and blood transfusion in addition to the six basic functions are classified as providing comprehensive emergency obstetric care (CEmOC). This well-defined set of key actions targeting the main causes of maternal mortality enables monitoring, evaluating and comparing obstetric care within and between countries.

However, availability of skilled attendants or signal functions may not sufficiently reflect quality of care.[6, 10] In a multi-country survey including 29 countries and 357 large delivery facilities (over 1000 annual deliveries per facility), high coverage with three key signal functions did not translate into reduced maternal mortality.[10] The authors suggest that this might be due to delayed management of emergencies and lack of comprehensive patient care. For example, septic shock requires comprehensive shock management in addition to antibiotic treatment measured by the signal function. Indeed, quality classification based on signal functions assumes that provision of certain

functions indicates that complications were recognized correctly and managed comprehensively without explicitly measuring the overall quality of clinical practice or competence of health workers.

In high-income settings, clinical vignettes have been shown to better reflect physicians' practice than medical record abstracts.[11, 12] They can provide information about procedural changes needed to improve health outcomes and are an inexpensive way of assessing competence, in particular when chart documentation is incomplete.[13] Therefore, vignettes could be an appealing and feasible way to study clinical practice and assess quality of obstetric care in low- and middle-income countries.

We used clinical vignettes as a part of a health facility assessment in Brong Ahafo region in Ghana to evaluate skills of delivery attendants and quality of care provided by delivery facilities. We compared competence between health worker cadres and between health facility types. To assess whether clinical practice was limited rather by facility infrastructure or by health worker competence, we compared competence in vignette actions with availability of necessary drugs and equipment. Finally, as a minimum workload and thus experience may be necessary to maintain competence, we studied the association between respondent competence and average workload at facilities.

METHODS

Data collection

We conducted a health facility assessment in all 86 health facilities providing care for mothers and newborns in seven districts in the central Brong Ahafo region of Ghana: Kintampo North and South, Nkoranza North and South, Tain, Techiman and Wenchi. Several large trials conducted in the area provided reliable health and demographic data relating to mothers and babies.[14-17] The pregnancy-related maternal mortality ratio in the area is estimated at 377 per 100 000 pregnancies[15] and neonatal mortality at 31 deaths per 1000 live births[18].

A physician and a research assistant collected data from all 86 health facilities in October and November 2010 by interviewing the most experienced provider managing deliveries and newborns present at each facility at the time of the visit. The health facility assessment included questions regarding staffing, infrastructure and equipment (including observation of tracer items), referral practices, antenatal care, routine delivery care, emergency obstetric and neonatal care. Detailed information on staffing was collected, including numbers of health care professionals managing deliveries, complications and newborns. Vignettes were used to capture competence in managing critical maternal and newborn emergencies (details below).

Health facilities

The health facilities in the study area have previously been classified in terms of their routine and emergency obstetric care (EmOC) and emergency newborn care (EmNC) performance[19] and in terms of quality of care provided for newborns[20]. The Newhints trial[14] surveillance system collected information on every pregnancy in the study area between November 2008 and December 2009, including the specific delivery facility for facility births.

In this analysis, we focused on the 64 facilities in the area providing delivery care. These included one regional hospital, 10 other hospitals (level C), 34 public health centres (level B), 11 private maternity homes (level A) and eight small

public facilities to which we refer collectively as "clinics" (level A). Among the hospitals, the regional hospital functioned as the referral facility for the area, four were main district hospitals, four were other district hospitals and two were private hospitals. The 64 respondents included three doctors, 38 midwives, five medical assistants, nine nurses, and nine belonging to "other" cadres. The group "nurses" included community health nurses, enrolled nurses, public health nurses and staff nurses. The group "others" included health assistants, health extension workers, trained traditional birth attendants and ward assistants.

Vignettes and scores

The first vignette (case A) describes a pregnant woman with signs and symptoms of pre-eclampsia, and the second vignette (case B) represents a case of severe antepartum haemorrhage. Each vignette is divided into a section on diagnosis and a section on management that were read to the respondents separately. Respondents provided open responses and were asked if they would do anything else until they explicitly said no. The interviewer then marked which items from a list of actions were mentioned. The list of vignette actions included a number of best practice actions according to WHO Pregnancy, Childbirth, Postpartum and Newborn Care guidelines[21] for primary level of care and some additional actions, such as supplemental oxygen administration and blood transfusion, that can be performed at a referral-level facility or in a very well-functioning first-line facility (Table 1).

Table 1. Vignette cases and construction of vignette score.	
Case A. Section 1. **A 26-year-old woman who is 7 months pregnant comes in complaining of headaches, blurred vision and epigastric pain and her face looks swollen. In this facility, what would you usually do to establish a diagnosis?**	
Vignette action	**Vignette score**
Measure the woman´s blood pressure [†]	+ 1 point if mentioned
Check her urine for protein [†]	+ 1 point if mentioned
Check her reflexes [†]	+ 1 point if mentioned
Check fetal heart rate [†]	+ 1 point if mentioned
Refer to other health facility [†]	+ 1 point if at least one out of two mentioned or if respondent is a specialist (i.e. a doctor)
Call specialist	
	Section maximum: 5 points
Case A. Section 2. **Upon examination she had a blood pressure of 170/120 mmHg, 3+ protein in her urine and brisk reflexes. How would she be managed at this facility?**	
Vignette action	**Vignette score**
Giving antihypertensive drug, e.g. hydralazine, labetalol or nifedipine [†]	+ 1 point if mentioned
Give magnesium sulfate or, if not available, diazepam [†]	+ 1 point if mentioned
Have somebody stay with her all the time in case she starts having seizures [†]	+ 1 point if mentioned
Plan for delivery within the next 24 hours	+ 1 point if at least one out of two mentioned
Refer to other health facility [†]	
	Section maximum: 4 points
Case B. Section 1. **A 35-year-old woman who is 8 months pregnant comes to this facility because she has started to bleed heavily vaginally. She has no contractions and does not complain of any pain. In this facility, what would you usually do to establish a diagnosis?**	
Vignette action	**Vignette score**
Check the woman´s vital signs [†]	+ 1 point if mentioned
Check fetal heart rate	+ 1 point if mentioned
Perform abdominal examination	+ 1 point if mentioned
Do not perform vaginal examination [†]	+ 1 point if mentioned
Refer to other health facility [†]	+ 1 point if at least one out of two mentioned
Call specialist	
	Section maximum: 5 points
Case B. Section 2. **The woman has a feeble pulse at 120 per minute, her systolic blood pressure is 85 and she is pale, sweating and breathing rapidly at 30 breaths per minute. Fetal heart sound is normal. There is no pain on abdominal examination. She is still bleeding vaginally, bright red blood. You suspect placenta praevia and therefore do not perform a vaginal examination. How would such a patient be managed now?**	
Vignette action	**Vignette score**
Elevate legs to increase return of blood to the heart [†]	+ 1 point if mentioned
Give intravenous fluids rapidly [†]	+ 1 point if mentioned
Give oxygen by mask or nasal cannula	+ 1 point if mentioned
Perform ultrasound to confirm diagnosis	+ 1 point if mentioned
Give blood transfusion	+ 1 point if mentioned
Prepare for caesarean section	+ 1 point if at least one out of two mentioned
Refer to other facility [†]	
	Section maximum: 6 points
Case A and Case B	***Total maximum: 20 points***
[†] *Vignette actions mentioned in WHO Pregnancy, Childbirth, Postpartum and Newborn care.*[21]	

The vignette score was created by assigning one point to each action that could be performed in any kind of facility (i.e. both a first-line facility and a referral facility). As caesarean section can only be executed in a referral facility, respondents got one point if the respondent said they would refer the woman to another facility even if the action was not mentioned specifically (Table 1). Combining both case A and B, the scores for the diagnostic section and management section were ten points each adding up to an overall maximum score of 20 points. Respondent competence was classified as "high" for >15 points (>75%), "moderate" for 10-15 points (50-75%) and "low" for <10 points (<50%).

As a sensitivity analysis, two alternative vignette scores were created, one that weighed the actions by their clinical importance, and one for which mentioning life-saving key interventions was a requirement. As there were no major differences in results with these alternative scores, we present the simpler approach of assigning one point per action.

Data analysis

We compared median overall vignette scores by respondent cadre using Kruskal-Wallis tests. If the vignette scores measure clinical competence, higher cadres should have higher scores. We also compared median vignette scores by facility type (hospitals, maternity homes, health centres and clinics) using Kruskal-Wallis tests.

To identify whether availability of drugs and equipment or clinical competence were the limiting factor in executing vignette actions, we compared six vignette answers with the availability of corresponding items: for example, administering intravenous fluids was compared with availability of infusion sets.

Lastly, the association between vignette score and workload was analysed using linear regression as regular experience in managing deliveries should translate into increased competence in emergency obstetric care. Workload was defined as the average number of annual deliveries of a facility in 2009 divided by the

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number of skilled birth attendants working in that facility. There were altogether 13 692 deliveries in the study area in 2009. We defined a skilled birth attendant (SBA) as a doctor, medical assistant, midwife or nurse trained in managing deliveries. For this analysis, stillbirths were counted as deliveries and multiple births were counted as one delivery.

Ethical approval and informed consent

Ethical approval for this study was obtained from the London School of Hygiene and Tropical Medicine in the UK, and from the Kintampo Health Research Centre in Ghana. Health professionals included in the health facility assessment signed a written informed consent before the start of the interview. For the Newhints trial, consent was obtained from all women of reproductive age living in the surveillance area (Newhints[14] – clinicaltrials.gov, NCT00623337).

RESULTS

Of the 86 facilities in the study area, 64 (74%) provided delivery care and were included in this analysis. Sixty-nine per cent of the 13 692 deliveries in the area in the year 2009 took place in a health facility.

Competence by health worker cadre

The median total vignette score was 40% of actions mentioned correctly with a range from 5% to 75%. For nearly three quarters (72%) of all respondents, competence was classified as low (<50%) and none of the respondents achieved a high score (>75%). The vignette score differed significantly between respondent cadres, showing a clear trend (Figure 1a): The three doctors had the highest scores with a median of 70% (range 50-75%), the 38 midwives scored a median of 45%, the five medical assistants and nine nurses 35% and the nine other cadres 20%. A doctor, a public health nurse and two midwives scored the highest points overall (75%). Doctors performed equally well in the sections relating to diagnosis (63%) and management (67%), and they performed better in both sections compared to other cadres (Figure 1b). Midwives were the second best cadre with 46% correct in diagnosis and 48% in management. Nurses did better in diagnosis (41%) than in management (27%), and the other respondents had an equally low percentage in diagnosis (20%) and management (23%).

Competence by type of delivery facility

Higher vignette scores were strongly associated with the type of delivery facility (p<0.001, Figure 2). Respondents in the 11 hospitals achieved the highest score with a median of 70% (range 45-75%); respondents were eight midwives, one nurse and two doctors. Maternity home and health centre respondents were mainly midwives and both had a similar level of vignette competence with a median of 40%. Health workers in clinics, also mainly midwives, scored lowest in the vignettes with a median score of 30% (range 5-40%). (Figure 2, Table 2)

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Table 2. Respondent cadre by facility type (n=64).					
Facility type	Doctors	Medical assistants	Midwives	Nurses	Others
Hospitals (n=11)	2 (18%)	0	8 (73%)	1 (9%)	0
Health centres (n=34)	1 (3%)	5 (15%)	18 (53%)	4 (12%)	6 (18%)
Clinics (n=8)	0	0	4 (50%)	2 (25%)	2 (25%)
Maternity homes (n=11)	0	0	8 (73%)	2 (18%)	1 (9%)
Total (n=64)	3 (5%)	5 (8%)	38 (59%)	9 (14%)	9 (14%)

Infrastructure and competence

Both lack of necessary drugs and equipment, and lack of knowledge on how and when to use them in practice, would limit diagnosis and management of a woman presenting with pre-eclampsia or antepartum haemorrhage in facilities. Our comparison revealed that the limiting factor in the majority of cases was competence (Figure 3): In all facility types, required drugs and equipment were more frequently available than the actions were mentioned in the vignettes, with one exception; administering antihypertensive drugs was mentioned more frequently (44% of health centres) than they were available (35% of health centres). All hospitals had all six items available and hospital respondents were more likely to mention the corresponding actions in the vignettes compared to respondents of other facility types.

Of the drugs and equipment studied with their corresponding vignette actions, the sphygmomanometer to measure blood pressure, intravenous fluids with infusion sets, and fetoscope or an electronic fetal heart monitor were the most frequently available equipment items present in nearly all facilities (≥ 97%). Blood pressure measurement and administering intravenous fluids were also mentioned frequently, but surprisingly only 22% of facility respondents mentioned assessing fetal distress in the vignette featuring a pre-eclamptic woman (case A). In hospitals, monitoring fetal heart sounds in case A was mentioned approximately twice as often (55%) as in maternity homes (27%) and nearly four times as often as in health centres (15%). Assessing fetal distress of a woman with antepartum haemorrhage was slightly more common and mentioned by 34% of all respondents. Although all clinics had a fetoscope

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available, none of the staff interviewed in clinics mentioned during the vignettes that they would apply it in practice.

Anticonvulsants were available in 94% of all facilities, but in the pre-eclampsia vignette, they were only mentioned by 50% of respondents in facilities where it was available. While 91% of hospital respondents reported they would administer anticonvulsants, only 41% of respondents in health centres and 45% in maternity homes answered that they would have administered these to the pre-eclamptic woman. Half of all clinics and 45% of maternity homes had antihypertensive drugs available and their use was mentioned in the vignette by 25% of clinics and 18% of maternity homes where these items were available. Oxygen was available in 48% of all facilities, but only 5% of all respondents mentioned administering supplemental oxygen to a woman presenting with severe antepartum haemorrhage. No clinic had oxygen available, but three quarters of maternity homes and a third of health centres had oxygen cylinders, and all hospitals. However, none of the health workers interviewed in maternity homes and health centres, and only 27% of hospital respondents would have administered supplemental oxygen to a woman presenting with antepartum haemorrhage.

Workload and competence

The overall number of skilled birth attendants working in facilities ranged from 0-2 in clinics, 0-4 in maternity homes, 0-8 in health centres and 3-53 in hospitals. The overall median frequency of deliveries per SBA per year was 26 (range 0-184) and the mean was 39 deliveries per SBA.

The highest workload was in hospitals with a median of 52 deliveries annually per SBA (Figure 4). The facility that managed the highest workload was a hospital with a total of 2 398 deliveries in the year 2009 and 13 SBAs, resulting in 184 deliveries per SBA. The workload was unevenly distributed between hospitals: In four of the eleven hospitals, each SBA attended on average to less than two deliveries per year and in three hospitals the delivery workload was more than 100 deliveries per SBA per year. Maternity homes had the second

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highest workload with a median of 45 deliveries annually per SBA, followed by health centres (21 deliveries per SBA) and clinics (13 deliveries per SBA). Workload in clinics ranged from 0 to 42 deliveries per SBA, with one outlier, a rural clinic with one SBA and 104 deliveries in 2009. The second highest delivery workload overall was in a health centre with one SBA only and 135 deliveries. A higher delivery workload in a facility was associated with a higher competence as measured with the vignettes (p=0.007; Figure 5).

Five of the 64 delivery facilities employed SBAs but did not manage deliveries during the surveillance period, and three delivery facilities employed no SBAs but managed altogether 57 deliveries. If all 13 692 deliveries in the surveillance data in 2009 had taken place in the 64 delivery facilities, managed by the 273 SBAs (or by the 189 midwives) employed there, the average delivery workload would have been 50 deliveries per SBA (or 72 deliveries per midwife).

DISCUSSION

We found that competence in handling obstetric emergencies as measured by two clinical vignettes varied markedly by cadre and facility type. The two cadres with most training in obstetric care - doctors and midwives - scored highest in the vignettes, as expected. However, even doctors and midwives were classified as only moderately competent and there was a wide variation in vignette score within cadres. The association of higher vignette score with facility type likely reflects the availability of more experienced and skilled staff in hospitals compared to smaller facilities. Also, smaller facilities are likely to achieve lower scores due to lack of blood transfusion and diagnostic ultrasound which are often only available in hospitals. Despite the low overall performance of health professionals, these expected findings support the validity of the two vignettes in assessing competence of delivery staff.

It has been suggested that clinical vignettes are a particularly useful way of assessing quality of clinical practice in low-and middle-income countries because chart abstraction is time-consuming and can be unreliable even in high-income countries.[22, 23] Clinical vignettes have been used in low-and middle-income settings in a variety of ways.[20, 23-27] For instance, quality of care for diarrhoea, tuberculosis and prenatal care was evaluated using vignettes in a cross-country study including 300 physicians in five middle-income countries – China, the Philippines, El Salvador, India and Mexico.[26] In that study, the average quality of care was similarly low across countries, and there was high variation of performance within countries with some exceptionally well-performing physicians. The authors concluded that availability of resources is not the only or even an important predictor of competence, and that improvements in quality could be achieved by targeting poor performers.

Comparison of vignette actions and necessary drugs and equipment in our study illustrated the lack of these inexpensive key items and lack of competence to use these in clinical situations. In many cases when the items were available, they were still not mentioned in the vignettes when they should have been,

suggesting that competence was the limiting factor. For example, while nearly all facilities had equipment to monitor fetal distress, it was rarely mentioned in the vignettes despite the fact that use of a fetoscope is relatively straightforward, there are no additional costs associated with its use and assessing fetal distress should be among the first examinations of a woman presenting with an obstetric emergency. Another striking finding was the non-availability of supplemental oxygen in clinics and how infrequently it was mentioned in the vignettes; Oxygen was available in 48% of all facilities, but only 5% of respondents mentioned administering oxygen to the woman in bleeding shock. This example represents a double gap: a resource gap and a competence gap. In most instances the larger gap was in competence, which reveals a major missed opportunity.

Human resource shortages have been identified as a large barrier to delivery care in Ghana.[5] The mean yearly workload found in this study (39 deliveries per SBA) are of similar magnitude as what has been reported for other sub-Saharan African countries.[28] Our estimates for workload are lower than the numbers reported by Witter et al. from the central and Volta regions of Ghana in 2005 where midwives working in public facilities were reported to carry out on average 19 deliveries weekly (corresponding to 988 annually) and midwives in private facilities attended to four deliveries weekly (208 annually).[29] It is possible that there are regional variations in workload within Ghana. Alternatively, the discrepancy may be due to methodological differences; the study by Witter et al. used self-reported data whereas we calculated the number of births per attendant by dividing the number of facility births from a surveillance system through the number of SBAs taken from a health facility assessment. If several providers attend to one delivery, the first method is going to give higher workloads.

The workload was unevenly distributed between facilities in our study area, even among hospitals. Except for one outlier with 104 yearly deliveries, the workload was very low in clinics; SBAs in clinics managed only a median of one delivery every 28 days. In five facilities, health professionals trained to manage deliveries did not attend to any deliveries during the one-year period. On the

other extreme, there was a facility with 184 births per SBA, or 343 births per midwife in a year, and three facilities – a maternity home, a clinic and a health centre – with only one SBA and more than a hundred deliveries in a year. This uneven distribution of deliveries among SBAs is likely to lead to worse quality of care as some SBAs are overburdened while others manage too few deliveries to maintain their professional skills. At the same time, nearly one in three women in the study area still delivered without SBA outside a health facility.

This study has several strengths and limitations. It was conducted in the Brong Ahafo Region in central Ghana and results can thus not be easily generalized to the whole of Ghana. However, the study area is large, comprising seven districts, and has a very similar maternal mortality ratio and facility delivery rates as in Ghana as a whole.[30]

Each of the facilities was visited only once during daytime, interviewing the most experienced member of staff present at the time. Therefore, the facility assessment is a snapshot of the quality of care provided in each facility, and it may have been better or worse at other points in time. In fact, in 21 facilities (33%) there were other employees registered belonging to a cadre with higher average vignette score than the respondent cadre. However, had the interviewer been a woman in labour, the respondent would have attended to her, and this would have been the quality of care available for her. Our evaluation thus captured the best competence available in each facility at the time of the interview.

While they do not provide information about routine care or other emergencies, our vignettes represent two major causes of maternal mortality that all health workers in charge of deliveries and all delivery facilities should be capable of diagnosing and managing or referring. It seems likely that higher competence as measured with these vignettes would result in health benefits, but as we did not study the association with a health outcome, we cannot be sure.

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A major shortcoming of vignettes, which they share with chart abstraction, is that they provide little information on personal interaction skills[13] that are arguably an important dimension of quality of care[28]. There is furthermore some debate in the literature on whether vignettes might capture knowledge instead of clinical practice and lead to overestimation of actual practice due to social desirability bias.[13, 26, 31] Despite this, we found a very low performance in the two vignettes, which raises serious concerns about the quality of basic emergency care in the area.

It is a strength of this study that all facilities with births in the surveillance area and all facilities offering delivery care were included in the health facility assessment. Knowing the number of births per facility from the surveillance system enabled us to calculate facility-level workloads, even though information on deliveries for individual health workers was not available. Not all health workers trained in deliveries necessarily manage them, and skilled birth attendants are likely to have other tasks besides managing deliveries.[5] Furthermore, the health facility data and the surveillance data were collected during different, subsequent years. It is possible that the number of births and/or the number of health workers was different in the following year, affecting the workload estimates, though this effect is unlikely to have been substantial. It is also possible that a few deliveries in the study area were missed by the surveillance. Some facilities managed deliveries of mothers living outside of the surveillance area. A regional hospital included in the facility assessment is in particular very likely to have attended deliveries from outside that were not included in the surveillance. Therefore, the workload estimates presented here are likely to be underestimates. This regional hospital was included in the analysis because it attends to all referred patients needing tertiary care from the study area, and excluding the regional hospital from the analysis did not change the overall results.

Conclusion

Health outcomes for women and their babies have not improved sufficiently despite increasing coverage with obstetric care, possibly because availability of

health workers and essential interventions might not correspond to overall quality of care.[6, 10, 32] One explanation for this mismatch might be lack of health worker competence. Our results suggest that many health workers managing deliveries might not be competent in diagnosing and managing obstetric emergencies and that in particular health workers other than midwives and doctors might not be able to provide sufficient quality.

Another issue related to quality of care is the unequal distribution of workload between facilities. Optimally, an appropriate workload translates into skills and experience. A component of high quality of care is ensuring a workload high enough for the maintenance of professional skills, without being so high that staff are overburdened. Collecting facility-level data on workload could allow for a more efficient distribution of limited human resources within a health system.

Evaluating competence with vignettes in addition to checklist items or chart abstraction could be part of a more comprehensive approach to measuring quality of care. In low- and middle-income settings, reliable patient records are often missing.[30, 33] Chart abstracts and direct observation of care are resource-consuming[22], and using standardized patients to evaluate emergency care is impossible. Vignettes provide an opportunity to evaluate whether health worker practice is deficient due to infrastructure or competence[13] to identify poorly performing health worker cadres and target training to them [26] or reconsider task-shifting, and to understand the reasons when increased coverage of interventions does not translate into improved health outcomes.

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December 19, 2015

Dr. Trish Groves
Editor-in-Chief, *BMJ Open*

Dear Dr. Groves,

Please find attached a new manuscript entitled "Competence of health workers in emergency obstetric care: An assessment using clinical vignettes in Brong Ahafo region, Ghana." It has not been previously submitted to another journal.

Facility delivery and coverage of essential interventions targeting major complications have not translated into reduced maternal or neonatal mortality in all countries. To evaluate skills of delivery attendants and the quality of care provided by delivery facilities, we conducted a health facility assessment in all 64 delivery facilities in seven districts of Brong Ahafo region in Ghana.

We used clinical vignettes to assess provider competence and studied associations with provider cadre, facility characteristics, and workload. The strikingly low competence achieved by some cadres with least training in obstetric care suggests that these cadres are not able to diagnose and manage complicated deliveries. We also show that lack of competence, rather than actual lack of relevant drugs and equipment is the main constraint in the clinical vignette situations. Furthermore, we found that facilities with low workload performed worse on the vignettes, which raises questions about the distribution of the workforce.

The submitted article builds upon our quality classification of these facilities[1] and complements our previous work on quality of newborn care published in your journal[2]. We believe that vignettes are a simple and powerful tool to measure quality of care more comprehensively and that their use can contribute to a better understanding of why increased coverage of facility delivery does not necessarily result in improved health outcomes.

Looking forward to hearing from you.

Sincerely yours,

Terhi Lohela

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[1] Nesbitt RC, Lohela TJ, Manu A et al. Quality along the continuum: a health facility assessment of intrapartum and postnatal care in Ghana. PLoS One 2013;8(11):e81089
[2] Vesel L, Manu A, Lohela TJ. Quality of newborn care: a health facility assessment in rural Ghana using survey, vignette and surveillance data. BMJ Open 2013:3(5)

1
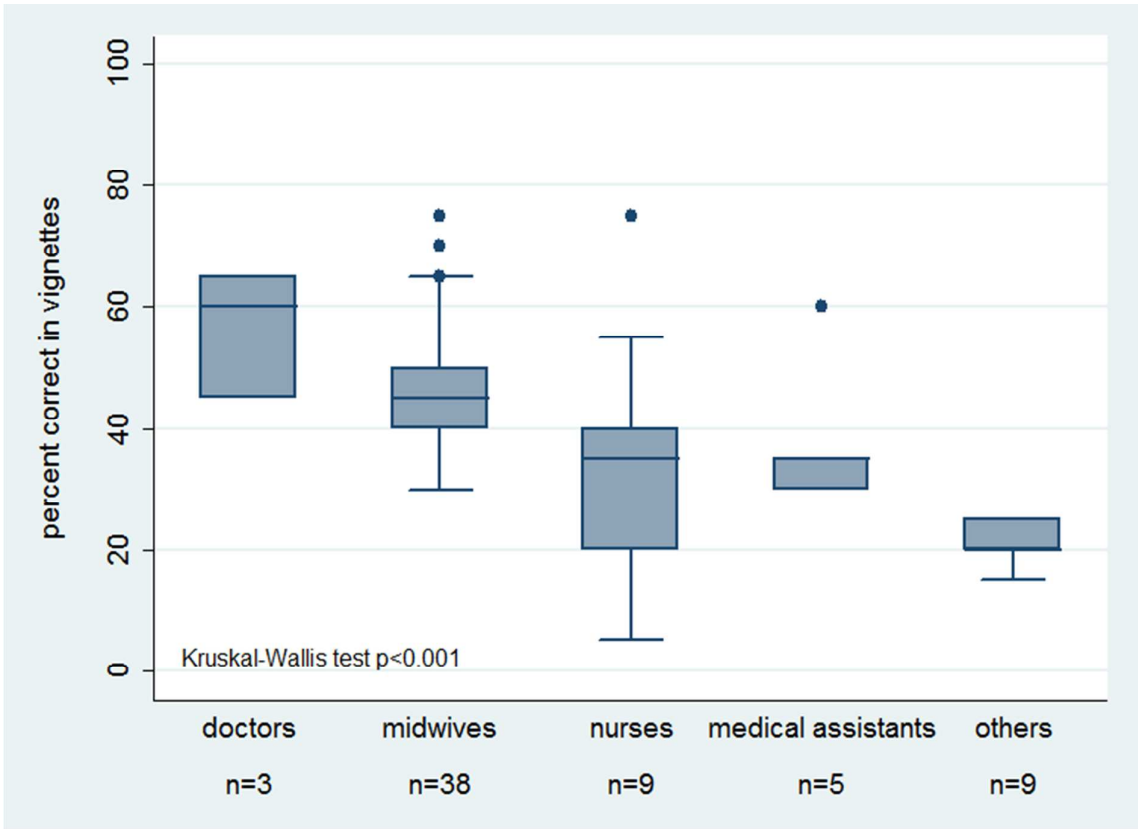
Figure 1a. Vignette score by respondent cadre in delivery facilities (n=64). The boxes show the middle 50% of the scores, the vertical lines show the range of scores, the central horizontal line represents the median score and outliers are represented by the dots. The group "others" includes health assistants, health extension workers, traditional birth attendants and ward assistants.
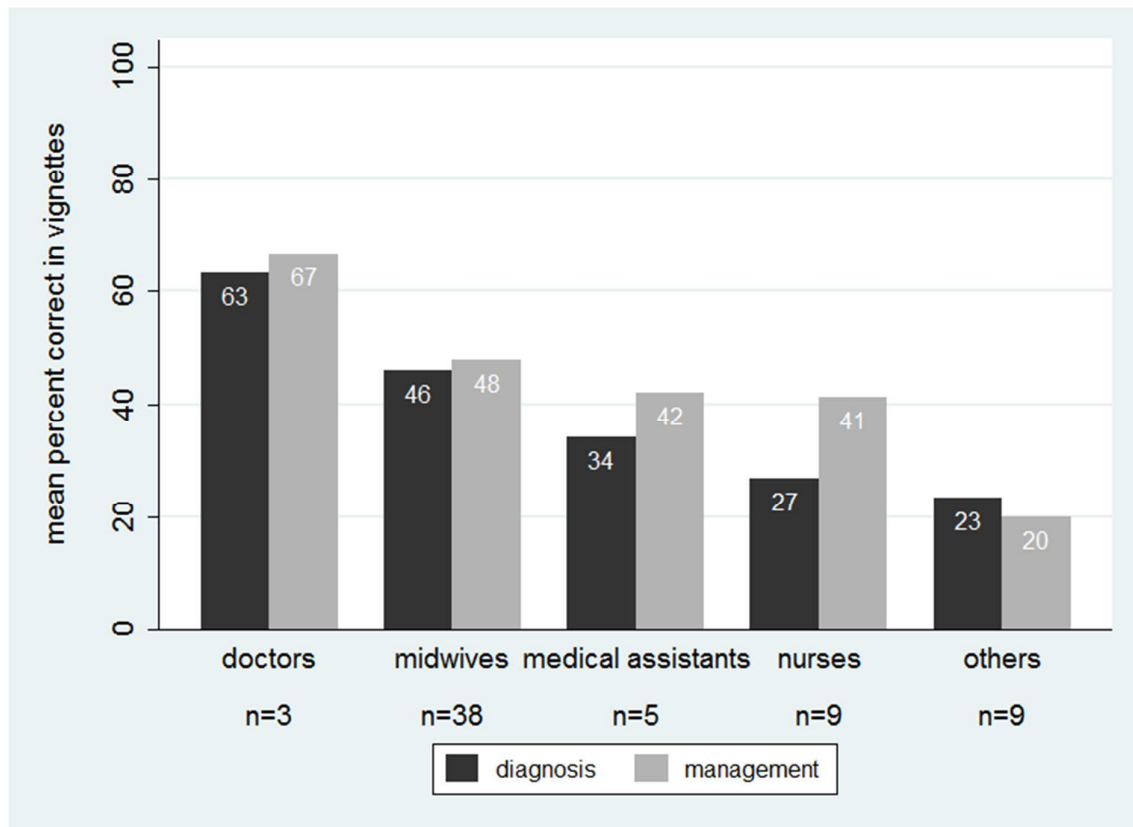
Figure 1b. Vignette score by vignette section and by respondent cadre (n=64). The group "others" includes health assistants, health extension workers, trained traditional birth attendants and ward assistants.
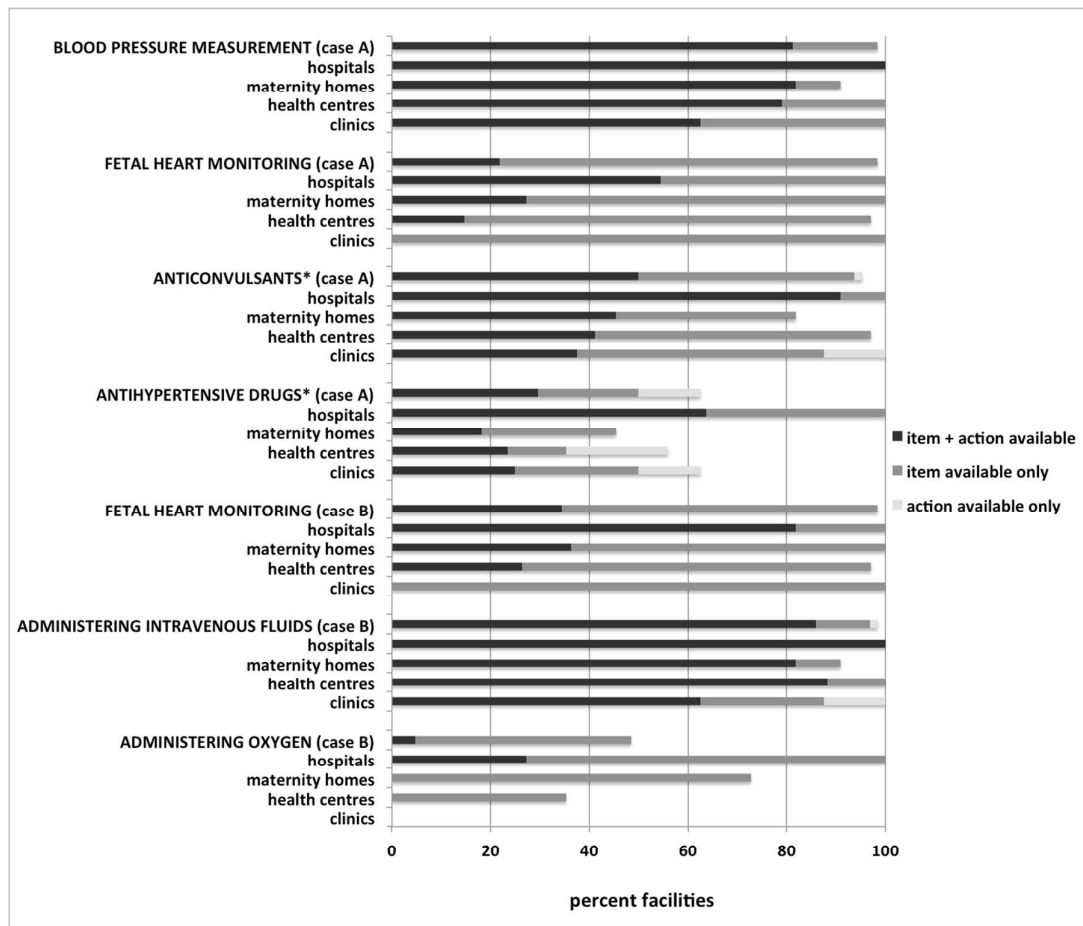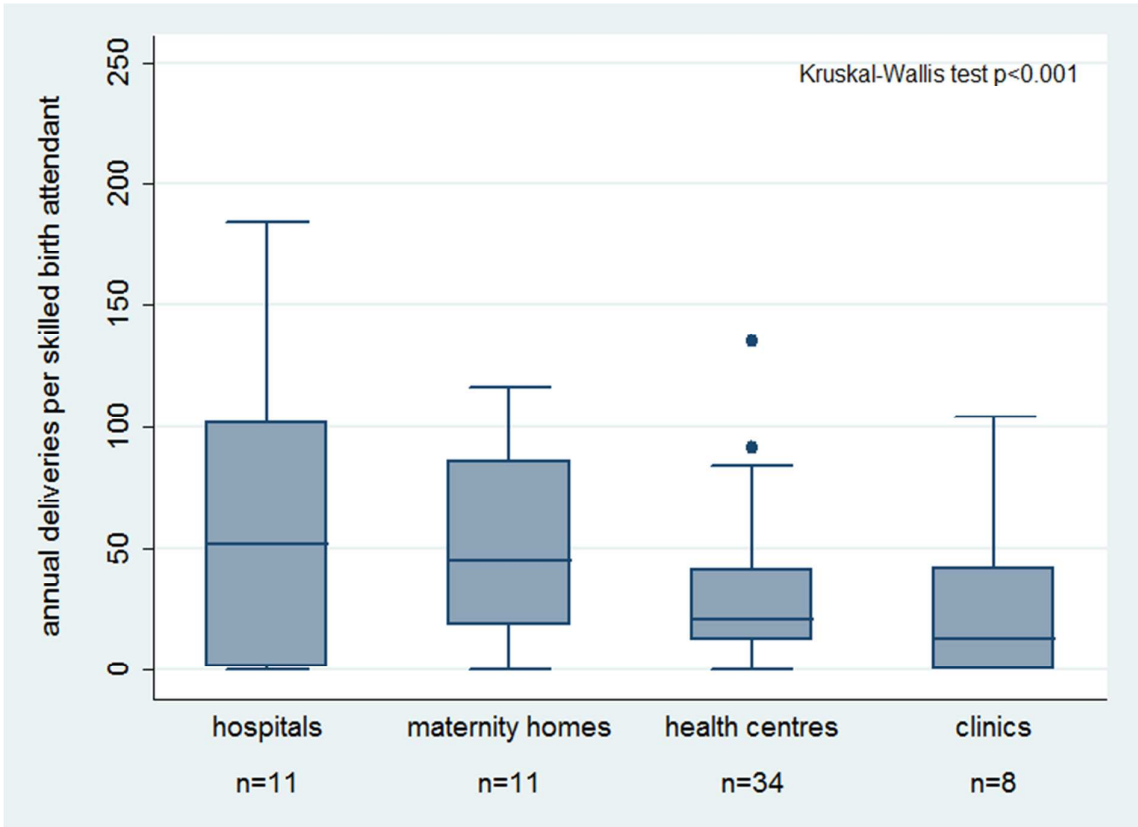
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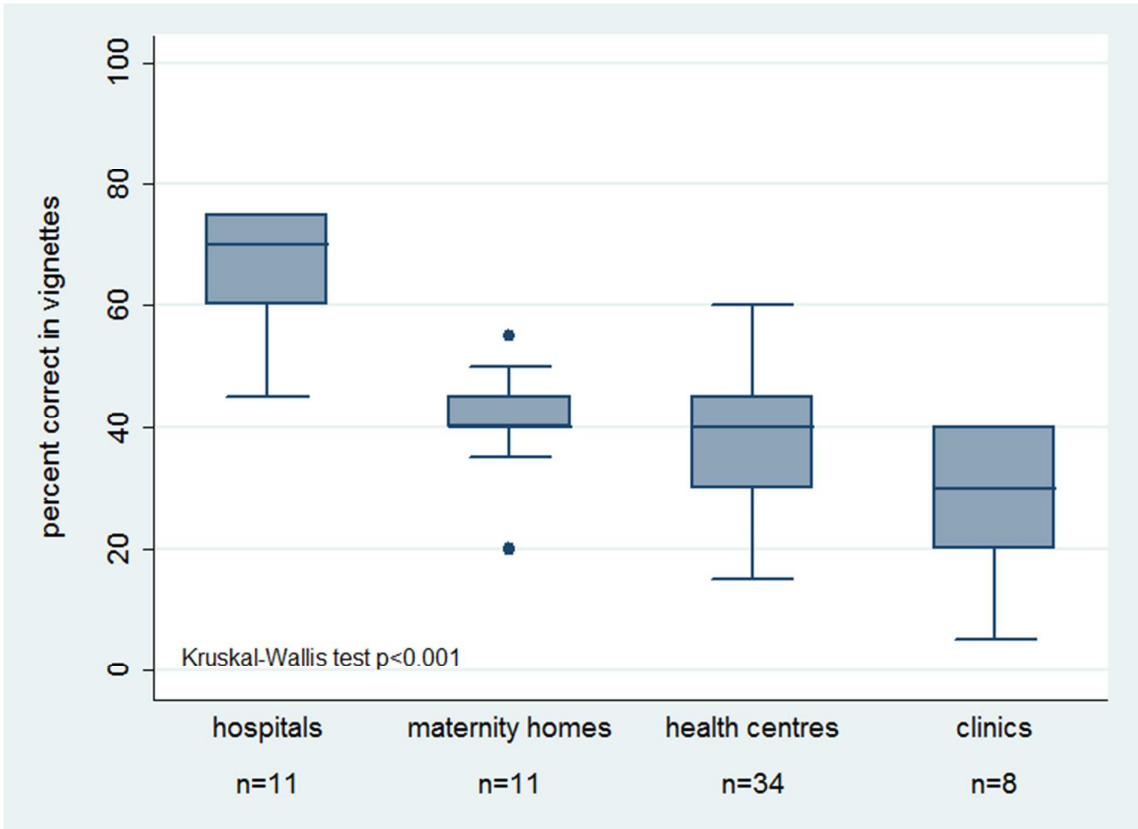
Figure 2. Vignette score by health facility type (n=64). The boxes show the middle 50% of the scores, the vertical lines show the range of scores, the central horizontal line represents the median score and outliers are represented by the dots. The group "clinics" includes clinics, health posts and Community-based Health Planning and Service compounds.

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Figure 3. Vignette actions with corresponding health facility assessment checklist items for all facilities combined and by facility type (n=64). Group "clinics" includes clinics, health posts and Community-based Health Planning and Service compounds.
* Administering parenteral anticonvulsants (magnesium sulfate or diazepam) or parenteral antihypertensive drugs (hydralazine, nifedipine or labetalol).
Missing part of bar is proportion of facilities where neither item was available nor action mentioned.

Figure 4. Distribution of workload among delivery facilities (n=64). The boxes show the middle 50% of the scores, the vertical lines show the range of scores, the central horizontal line represents the median score and outliers are represented by the dots. Group "clinics" includes clinics, health posts and Community-based Health Planning and Service compounds.
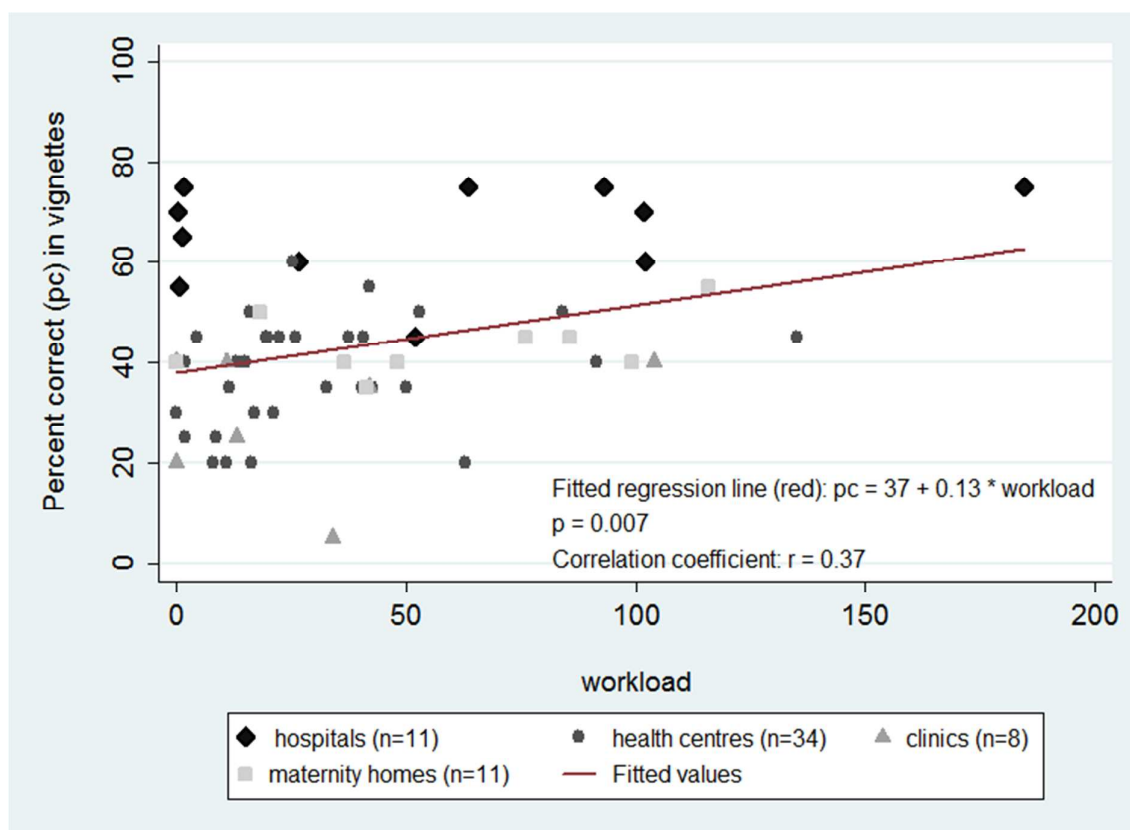
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Figure 5. Association between the vignette score and delivery facility workload (n=60). Three facilities without skilled birth attendants and one facility without skilled birth attendants and deliveries are excluded from the analysis.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Done?
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	p. 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p. 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p. 4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	p. 5
Methods			
Study design	4	Present key elements of study design early in the paper	p. 6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p. 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	p. 6-7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p. 9-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p. 6-7, 9
Bias	9	Describe any efforts to address potential sources of bias	p. 9
Study size	10	Explain how the study size was arrived at	p. 6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p. 6-7, 9-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p. 9-10
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	p. 9

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	p.11
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	N/A
		(b) Indicate number of participants with missing data for each variable of interest	p. 11 (NONE)
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	p. 11-14
		(*b*) Report category boundaries when continuous variables were categorized	p. 11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	p. 15-17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p. 17-18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p. 18-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	p. 17,19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p. 20

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Competence of health workers in emergency obstetric care: An assessment using clinical vignettes in Brong Ahafo region, Ghana.

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Keywords:	Quality of care, Emergency obstetric care, Clinical vignettes, Human resource management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Signal functions, Health facility assessment

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Competence of health workers in emergency obstetric care: An assessment using clinical vignettes in Brong Ahafo region, Ghana.

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Keywords

clinical vignettes; emergency obstetric care; human resources; workload; competence; health facility assessment; signal functions; quality of care

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ABSTRACT

Objectives: To assess health worker competence in emergency obstetric care using clinical vignettes, and to link competence to availability of infrastructure in facilities, and to average annual delivery workload in facilities.

Design: Cross-sectional Health Facility Assessment, linked to population-based surveillance data.

Setting: Seven districts in Brong Ahafo region, Ghana.

Participants: Most experienced delivery care providers in all 64 delivery facilities in the seven districts.

Primary outcome measures: Health worker competence in clinical vignette actions by cadre of delivery care provider and by type of facility. Competence was also compared to availability of relevant drugs and equipment and to average annual workload per skilled birth attendant.

Results: Vignette scores were moderate overall, and differed significantly by respondent cadre ranging from a median of 70% correct among doctors, via 55% among midwives to 25% among other cadres such as health assistants and health extension workers ($p<0.001$). Competence varied significantly by facility type: Hospital respondents, who were mainly doctors and midwives, achieved highest scores (70% correct) and clinic respondents scored lowest (45% correct). There was a lack of inexpensive key drugs and equipment to carry out vignette actions, and more often, lack of competence to use available items in clinical situations. The average annual workload was very unevenly distributed among facilities, ranging from 0 to 184 deliveries per skilled birth attendant; with higher workload associated with higher vignette scores.

Conclusions: Lack of competence might limit clinical practice even more than lack of relevant drugs and equipment. Cadres other than midwives and doctors might not be able to diagnose and manage delivery complications. Checking clinical competence through vignettes in addition to checklist items could contribute to a more comprehensive approach to evaluate quality of care.

Trial registration: http://clinicaltrials.gov NCT00623337.

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ARTICLE SUMMARY

Strengths and limitations of this study

- We used clinical vignettes to assess health worker competence in rural Ghana, choosing two major causes of maternal mortality that independently working delivery care professionals should be able to diagnose and manage.

- While not nationally or longitudinally representative, our health facility assessment included all 64 delivery facilities in seven districts of Brong Ahafo region and captured the best competence available at the time of interview.

- Despite limited sample size and risk of social desirability bias in vignettes, we were able to clearly identify serious shortcomings in health worker competence in the area.

- We used available surveillance data in the districts to estimate births per facility and found an association between competence and workload.

INTRODUCTION

Skilled birth attendants are crucial to reducing the 289,000 maternal deaths, 2.8 million neonatal deaths and 2.6 million stillbirths that still occur every year.[1-4] Shortage of midwives, especially in remote locations, has led to training of health care professionals other than midwives to manage deliveries.[5] Presence of a skilled attendant at birth is one of the main indicators of progress towards improving outcomes related to pregnancy and childbirth, however, the approach of increasing coverage with birth attendants without assessing their skills has been criticized for ignoring quality.[6]

Measuring quality of care is challenging because quality is a multidimensional concept without a universal definition.[7, 8] Quality of emergency obstetric care in low-and middle-income settings is often evaluated with signal functions that indicate the capacity of a facility to perform certain life-saving interventions.[9] Usually, performance of a signal function within the past three months is verified using patient chart abstracts. Facilities performing a set of six basic signal functions are classified as providing basic emergency obstetric care (BEmOC), and facilities performing emergency surgery (e.g. caesarean delivery) and blood transfusion in addition to the six basic functions are classified as providing comprehensive emergency obstetric care (CEmOC). This well-defined set of key actions targeting the main causes of maternal mortality enables monitoring, evaluating and comparing obstetric care within and between countries.

However, availability of skilled attendants or signal functions may not sufficiently reflect quality of care.[6, 10] In a multi-country survey including 29 countries and 357 large delivery facilities (over 1000 annual deliveries per facility), high coverage with three key signal functions did not translate into reduced maternal mortality.[10] The authors suggest that this might be due to delayed management of emergencies and lack of comprehensive patient care. For example, septic shock requires comprehensive shock management in addition to antibiotic treatment measured by the signal function. Indeed, quality classification based on signal functions assumes that provision of certain

functions indicates that complications were recognized correctly and managed comprehensively without explicitly measuring the overall quality of clinical practice or competence of health workers.

In high-income settings, clinical vignettes have been shown to better reflect physicians' practice than medical record abstracts.[11, 12] They can provide information about procedural changes needed to improve health outcomes and are an inexpensive way of assessing competence, in particular when chart documentation is incomplete.[13] Therefore, vignettes could be an appealing and feasible way to study clinical practice and assess quality of obstetric care in low- and middle-income countries.

In this paper, we assess competence of health workers in delivery facilities in Brong Ahafo region in Ghana using clinical vignettes. We compare competence between health worker cadres and between health facility types. To assess whether clinical practice was limited rather by facility infrastructure or by health worker competence, we compare competence in vignette actions with availability of necessary drugs and equipment. Finally, as a minimum workload and thus experience may be necessary to maintain competence, we study the association between respondent competence and average workload at facilities.

METHODS

Study design

A cross-sectional health facility assessment was conducted to study health worker competence in emergency obstetric care, and linked to population-based surveillance data on place of birth.

Setting

The study was conducted in all 86 health facilities providing care for mothers and newborns in seven districts in the central Brong Ahafo region of Ghana in October and November 2010: Kintampo North and South, Nkoranza North and South, Tain, Techiman and Wenchi. Several large trials conducted in the area provided reliable health and demographic data relating to mothers and babies.[14-17] The maternal mortality ratio in the area is estimated at 377 per 100 000 pregnancies[15] and neonatal mortality at 31 deaths per 1000 live births[18].

Health facilities

In this analysis, we focused on the 64 facilities in the area providing delivery care as we aimed to study emergency obstetric care. These facilities included one public regional hospital, 10 public, quasi-public (i.e. mission) and private hospitals (level C), 34 public health centres (level B), 11 private maternity homes (level A) and eight small public facilities to which we refer collectively as "clinics" (level A). Among the hospitals, the regional hospital functioned as the referral facility for the area, four were main district hospitals, four were other district hospitals and two were private hospitals. Fourteen facilities were located in urban areas: seven hospitals, one health centre and six maternity homes. The health facilities in the study area have previously been classified in terms of their routine and emergency obstetric care (EmOC) and emergency newborn care (EmNC) performance[19] and in terms of quality of care provided for newborns[20]. The Newhints trial[14] surveillance system collected information on every pregnancy in the study area between November 2008 and December 2009, including the specific delivery facility for facility births.

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Participants

The most experienced provider managing deliveries and newborns present at each facility at the time of the visit was interviewed. These 64 respondents included three doctors, 38 midwives, five medical assistants, nine nurses, and nine belonging to "other" cadres. The group "nurses" included community health nurses, enrolled nurses, public health nurses and staff nurses. The group "others" included health assistants, health extension workers, trained traditional birth attendants and ward assistants. The distribution of respondents in different facility types is presented in Table 1.

Table 1. Respondent cadre by facility type (n=64).					
Facility type	Doctors	Medical assistants	Midwives	Nurses	Others
Hospitals (n=11)	2 (18%)	0	8 (73%)	1 (9%)	0
Health centres (n=34)	1 (3%)	5 (15%)	18 (53%)	4 (12%)	6 (18%)
Clinics (n=8)	0	0	4 (50%)	2 (25%)	2 (25%)
Maternity homes (n=11)	0	0	8 (73%)	2 (18%)	1 (9%)
Total (n=64)	3 (5%)	5 (8%)	38 (59%)	9 (14%)	9 (14%)

Data collection

The health facility assessment, conducted by a physician and a research assistant, included questions regarding antenatal care, routine delivery care, emergency obstetric and neonatal care, referral practices, infrastructure and equipment (including observation of tracer items). Detailed information on staffing was also collected, including numbers of health care professionals managing deliveries, complications and newborns. Clinical vignettes were used to capture competence in managing critical maternal and newborn emergencies.

Vignettes and scores

The first vignette (case A) describes a pregnant woman with signs and symptoms of pre-eclampsia, and the second vignette (case B) represents a case of severe antepartum haemorrhage. Each vignette is divided into a section on diagnosis and a section on management that were read to the respondents separately. Respondents provided open responses and were asked if they would do anything else until they explicitly said no. The interviewer then marked which items from a list of actions were mentioned. The list of vignette actions included a number of

best practice actions related to diagnosis and initial management of obstetric

emergencies according to WHO Pregnancy, Childbirth, Postpartum and Newborn

Care guidelines[21] for primary level of care and some additional actions, such

as supplemental oxygen administration, that can be performed at a referral-level

facility or in a very well-functioning first-line facility (Table 2).

Table 2. Vignette cases and construction of vignette score.	
Case A. Section 1. A 26-year-old woman who is 7 months pregnant comes in complaining of headaches, blurred vision and epigastric pain and her face looks swollen. In this facility, what would you usually do to establish a diagnosis?	
Vignette action	**Vignette score**
Measure the woman´s blood pressure[†]	+ 1 point if mentioned
Check her urine for protein[†]	+ 1 point if mentioned
Check her reflexes[†]	+ 1 point if mentioned
Check fetal heart rate[†]	+ 1 point if mentioned
Refer to other health facility[†]	+ 1 point if at least one out of two mentioned
Call specialist or respondent is a specialist (i.e. a doctor)	
	Section maximum: 5 points
Case A. Section 2. Upon examination she had a blood pressure of 170/120 mmHg, 3+ protein in her urine and brisk reflexes. How would she be managed at this facility?	
Vignette action	**Vignette score**
Giving antihypertensive drug, e.g. hydralazine, labetalol or nifedipine[†]	+ 1 point if mentioned
Give magnesium sulfate or, if not available, diazepam [†]	+ 1 point if mentioned
Have somebody stay with her all the time in case she starts having seizures[†]	+ 1 point if mentioned
Plan for delivery within the next 24 hours	+ 1 point if at least one out of two mentioned
Refer to other health facility[†]	
	Section maximum: 4 points
Case B. Section 1. A 35-year-old woman who is 8 months pregnant comes to this facility because she has started to bleed heavily vaginally. She has no contractions and does not complain of any pain. In this facility, what would you usually do to establish a diagnosis?	
Vignette action	**Vignette score**
Check the woman´s vital signs[†]	+ 1 point if mentioned
Check fetal heart rate	+ 1 point if mentioned
Perform abdominal examination	+ 1 point if mentioned
Do not perform vaginal examination[†]	+ 1 point if mentioned
Refer to a facility where caesarean delivery can be performed[†]	+ 1 point if at least one out of two mentioned
Call specialist or respondent is a specialist (i.e. a doctor)	
	Section maximum: 5 points
Case B. Section 2. The woman has a feeble pulse at 120 per minute, her systolic blood pressure is 85 and she is pale, sweating and breathing rapidly at 30 breaths per minute. Fetal heart sound is normal. There is no pain on abdominal examination. She is still bleeding vaginally, bright red blood. You suspect placenta praevia and therefore do not perform a vaginal examination. How would such a patient be managed now?	
Vignette action	**Vignette score**
Elevate legs to increase return of blood to the heart[†]	+ 1 point if mentioned
Give intravenous fluids rapidly[†]	+ 1 point if mentioned
Give oxygen by mask or nasal cannula	+ 1 point if at least one out of two mentioned
If oxygen unavailable, refer to a facility where caesarean delivery can be performed	
Perform ultrasound to confirm diagnosis	+ 1 point if at least one out of two mentioned
If ultrasound unavailable, refer to a facility where caesarean delivery can be performed	
Give blood transfusion	+ 1 point if at least one out of two mentioned
If blood transfusion unavailable, refer to a facility where caesarean delivery can be performed	
Prepare for caesarean delivery	+ 1 point if at least one out of two mentioned
Refer to a facility where caesarean delivery can be performed[†]	
	Section maximum: 6 points
Case A and Case B	*Total maximum: 20 points*
[†]*Vignette actions mentioned in WHO Pregnancy, Childbirth, Postpartum and Newborn care.*[21]	

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The vignette score was created by assigning one point to each action that could be performed in any kind of facility (i.e. both a first-line facility and a referral facility). For actions performed only or mainly at referral facilities, specifically ultrasound, blood transfusion, supplemental oxygen and caesarean delivery, respondents got one point if the action was not available at the respondent's facility and the respondent said they would refer the woman to a facility capable of performing a caesarean delivery, even if the action was not mentioned specifically (Table 2). Combining both case A and B, the scores for the diagnostic section and management section were 10 points each adding up to an overall maximum score of 20 points. Respondent competence was classified as "high" for >15 points (>75%), "moderate" for 10-15 points (50-75%) and "low" for <10 points (<50%).

As a sensitivity analysis, two alternative vignette scores were created, one that weighed the actions by their clinical importance, and one for which mentioning life-saving key interventions was a requirement. As there were no major differences in results with these alternative scores, we present the simpler approach of assigning one point per action.

Data analysis

We compared median overall vignette scores by respondent cadre using Kruskal-Wallis tests. If the vignette scores measure clinical competence, higher cadres should have higher scores. We also compared median vignette scores by facility type (hospitals, maternity homes, health centres and clinics) using Kruskal-Wallis tests.

To identify whether availability of drugs and equipment or clinical competence were the limiting factor in providing emergency obstetric care through executing vignette actions, we compared six vignette answers with the availability of corresponding items: for example, administering intravenous fluids was compared with availability of infusion sets.

The association between vignette score and workload was analysed using linear regression. Workload was defined as the average number of annual deliveries in a facility in 2009 divided by the number of skilled birth attendants working in that facility. There were altogether 13 692 deliveries in the study area in 2009. We defined a skilled birth attendant (SBA) as a doctor, medical assistant, midwife or nurse trained in managing deliveries. For this analysis, stillbirths were counted as deliveries and multiple births were counted as one delivery. All analyses were performed using Stata 12 (Statacorp. College Station, USA).

Ethical approval and informed consent

Ethical approval for this study was obtained from the London School of Hygiene and Tropical Medicine in the UK, and from the Kintampo Health Research Centre in Ghana. Health professionals included in the health facility assessment signed a written informed consent before the start of the interview. For the Newhints trial, consent was obtained from all women of reproductive age living in the surveillance area (Newhints[14] – clinicaltrials.gov, NCT00623337).

RESULTS

Of the 86 facilities in the study area, 64 (74%) provided delivery care and were included in this analysis. Sixty-nine per cent of the 13 692 deliveries in the area in the year 2009 took place in a health facility.

Competence by health worker cadre

The median total vignette score was 55% of actions mentioned correctly with a range from 5% to 75%. For 28% of all respondents, competence was classified as low (<50%) and none of the respondents achieved a high score (>75%). The vignette score differed significantly between respondent cadres, showing a clear trend (Figure 1a): The three doctors had the highest scores with a median of 70% (range 60-75%), the 38 midwives scored a median of 55%, the nine nurses 50%, five medical assistants 45% and the nine other cadres 25%. A doctor, one public health nurse and two midwives scored the highest points overall (75%). Doctors performed equally well in the sections relating to diagnosis (70%) and management (67%), and they performed better in both sections compared to other cadres (Figure 1b). Midwives were the second best cadre with 67% correct in diagnosis and 48% in management. Medical assistants had a moderate competence in diagnosis (52%) but low competence in management (40%). Their results were similar compared with nurses who had 49% in diagnosis and 41% in management. The other respondents scored a low percentage in diagnosis (33%) and in management (18%).

Competence by type of delivery facility

Higher vignette scores were strongly associated with the type of delivery facility (p<0.001, Figure 2). Respondents in the 11 hospitals achieved the highest score with a median of 70% (range 55-75%); respondents were eight midwives, one nurse and two doctors. Maternity home and health centre respondents were mainly midwives and both had a similar level of vignette competence with a median of 53% in health centres and 50% in maternity homes. Health workers in clinics, also mainly midwives, scored lowest in the vignettes with a median score of 45% (range 5-55%). (Figure 2, Table 1)

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Respondents in quasi-public facilities had a higher vignette competence with a median of 75% compared to private and public facilities where the median score was 55% (p=0.01). Competence varied more in public facilities (range 5-70%) and in private facilities (10-75%) compared to quasi-public facilities (60-75%). Health workers in urban facilities were more competent as judged by vignette scores (median 60%, range 45-75%) compared to rural respondents (median 55%, range 5-75%) (p=0.01).

Infrastructure and competence

Both lack of necessary drugs and equipment, and lack of knowledge on how and when to use them in practice, would limit diagnosis and management of a woman presenting with pre-eclampsia or antepartum haemorrhage in facilities. Our comparison revealed that the limiting factor in the majority of cases was competence (Figure 3): In all facility types, required drugs and equipment were more frequently available than the actions were mentioned in the vignettes, with one exception; administering antihypertensive drugs was mentioned more frequently (44% of health centres) than they were available (35% of health centres). All hospitals had all six items available and hospital respondents were more likely to mention the corresponding actions in the vignettes compared to respondents of other facility types.

Of the drugs and equipment studied with their corresponding vignette actions, the sphygmomanometer to measure blood pressure, intravenous fluids with infusion sets, and fetoscope or an electronic fetal heart monitor were the most frequently available equipment items present in nearly all facilities (≥ 97%). Blood pressure measurement and administering intravenous fluids were also mentioned frequently, but surprisingly only 22% of facility respondents mentioned assessing fetal distress in the vignette featuring a pre-eclamptic woman (case A). In hospitals, monitoring fetal heart sounds in case A was mentioned approximately twice as often (55%) as in maternity homes (27%) and nearly four times as often as in health centres (15%). Assessing fetal distress of a woman with antepartum haemorrhage was slightly more common and mentioned by 34% of all respondents. Although all clinics had a fetoscope

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available, none of the clinic staff mentioned during the vignettes that they would apply it in practice.

Anticonvulsants were available in 94% of all facilities, but in the pre-eclampsia vignette, they were only mentioned by 50% of respondents in facilities where it was available. While 91% of hospital respondents reported they would administer anticonvulsants, only 41% of respondents in health centres and 45% in maternity homes answered that they would have administered these to the pre-eclamptic woman. Half of all clinics and 45% of maternity homes had antihypertensive drugs available and their use was mentioned in the vignette by 25% of clinics and 18% of maternity homes where these items were available. Oxygen was available in 48% of all facilities, but only 5% of all respondents mentioned administering supplemental oxygen to a woman presenting with severe antepartum haemorrhage. No clinic had oxygen available, but three quarters of maternity homes and a third of health centres had oxygen cylinders, and all hospitals. However, none of the health workers interviewed in maternity homes and health centres, and only 27% of hospital respondents would have administered supplemental oxygen to a woman presenting with antepartum haemorrhage.

Workload and competence

The overall number of skilled birth attendants working in facilities ranged from 0-2 in clinics, 0-4 in maternity homes, 0-8 in health centres and 3-53 in hospitals. The overall median frequency of deliveries per SBA per year was 26 (range 0-184) and the mean was 39 deliveries per SBA.

The highest workload was in hospitals with a median of 52 deliveries annually per SBA. The facility that managed the highest workload was a hospital with a total of 2 398 deliveries in the year 2009 and 13 SBAs, resulting in 184 deliveries per SBA. The workload was unevenly distributed between hospitals: In four of the eleven hospitals, each SBA attended on average to less than two deliveries per year and in three hospitals the delivery workload was more than 100 deliveries per SBA per year. Maternity homes had the second highest workload

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with a median of 45 deliveries annually per SBA, followed by health centres (21 deliveries per SBA) and clinics (13 deliveries per SBA). Workload in clinics ranged from 0 to 42 deliveries per SBA, with one outlier, a rural clinic with one SBA and 104 deliveries in 2009. The second highest delivery workload overall was in a health centre with one SBA only and 135 deliveries. A higher delivery workload in a facility was associated with a higher competence as measured with the vignettes (p=0.03, Figure 4).

Five of the 64 delivery facilities employed SBAs but did not manage deliveries during the surveillance period, and three delivery facilities employed no SBAs but managed altogether 57 deliveries. If all 13 692 deliveries in the surveillance data in 2009 had taken place in the 64 delivery facilities, managed by the 273 SBAs (or by the 189 midwives) employed there, the average delivery workload would have been 50 deliveries per SBA (or 72 deliveries per midwife).

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DISCUSSION

We found that competence in first-line management of obstetric emergencies as measured by two clinical vignettes varied markedly by cadre and facility type. The two cadres with most training in obstetric care - doctors and midwives - scored highest in the vignettes, as expected. However, even doctors and midwives were classified as only moderately competent. Our results suggest that health workers other than midwives and doctors might not be able to provide sufficient quality, and there was a wide variation in vignette score within cadres. The association of higher vignette score with facility type likely reflects the availability of more experienced and skilled staff in hospitals compared to smaller facilities. The better competence of health workers in urban areas and in quasi-public facilities is in line with most urban facilities and all four quasi-public facilities being hospitals. Despite the moderate overall performance of health professionals, these expected findings support the validity of the two vignettes in assessing competence of delivery staff.

It has been suggested that clinical vignettes are a particularly useful way of assessing quality of clinical practice in low-and middle-income countries because chart abstraction is time-consuming and can be unreliable even in high-income countries.[22, 23] Clinical vignettes have been used in low-and middle-income settings in a variety of ways.[20, 23-27] For instance, quality of care for diarrhoea, tuberculosis and prenatal care was evaluated using vignettes in a cross-country study including 300 physicians in five middle-income countries – China, the Philippines, El Salvador, India and Mexico.[26] In that study, the average quality of care was similarly low across countries, and there was high variation of performance within countries with some exceptionally well-performing physicians. The authors concluded that availability of resources is not the only or even an important predictor of competence, and that improvements in quality could be achieved by targeting poor performers.

Comparison of vignette actions and necessary drugs and equipment in our study illustrated the lack of these inexpensive key items and lack of competence to use

these in clinical situations. In many cases when the items were available, they were still not mentioned in the vignettes when they should have been, suggesting that competence was the limiting factor. For example, while nearly all facilities had equipment to monitor fetal distress, it was rarely mentioned in the vignettes despite the fact that use of a fetoscope is relatively straightforward, there are no additional costs associated with its use and assessing fetal distress should be among the first examinations of a woman presenting with an obstetric emergency. Another striking finding was how infrequently oxygen was mentioned in the vignettes even when it was available; Oxygen was available in 48% of all facilities, but only 5% of respondents mentioned administering oxygen to the woman in bleeding shock. This example represents a double gap: a resource gap and a competence gap. In most instances the larger gap was in competence, which reveals a major missed opportunity.

Human resource shortages have been identified as a large barrier to delivery care in Ghana.[5] The mean yearly workload found in this study (39 deliveries per SBA) is similar to what has been reported for other sub-Saharan African countries.[28] Our estimates for workload are lower than the numbers reported by Witter et al. from the central and Volta regions of Ghana in 2005 where midwives working in public facilities were reported to carry out on average 19 deliveries weekly (corresponding to 988 annually) and midwives in private facilities attended to four deliveries weekly (208 annually).[29] It is possible that there are regional variations in workload within Ghana. Alternatively, the discrepancy may be due to methodological differences; the study by Witter et al. used self-reported data whereas we calculated the number of births per attendant by dividing the number of facility births from a surveillance system through the number of SBAs taken from a health facility assessment. If several providers attend to one delivery, the first method is going to give higher workloads.

The workload was unevenly distributed between facilities in our study area, even among hospitals. Except for one outlier with 104 yearly deliveries, the workload was very low in clinics; SBAs in clinics managed only a median of one delivery every 28 days. In five facilities, health professionals trained to manage

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deliveries did not attend to any deliveries during the one-year period. On the other extreme, there was a facility with 184 births per SBA, or 343 births per midwife in a year, and three facilities – a maternity home, a clinic and a health centre – with only one SBA and more than a hundred deliveries in a year. This uneven distribution of deliveries among SBAs is likely to lead to worse quality of care as some SBAs are overburdened while others manage too few deliveries to maintain their professional competence. At the same time, nearly one in three women in the study area still delivered without SBA outside a health facility.

This study has several strengths and limitations. It was conducted in the Brong Ahafo Region in central Ghana and results can thus not be easily generalized to the whole of Ghana. However, the study area is large, comprising seven districts, and has a very similar maternal mortality ratio and facility delivery rates as in Ghana as a whole.[30]

Each of the facilities was visited only once during daytime, interviewing the most experienced member of staff present at the time. Therefore, the facility assessment is a snapshot of the quality of care provided in each facility, and it may have been better or worse at other points in time. In fact, in 21 facilities (33%) there were other employees registered belonging to a cadre with higher average vignette score than the respondent cadre. However, had the interviewer been a woman in labour, the respondent would have attended to her, and this would have been the quality of care available for her. Our evaluation thus captured the best competence available in each facility at the time of the interview.

While they do not provide information about routine care or other emergencies, our vignettes represent two major causes of maternal mortality that all health workers in charge of deliveries and all delivery facilities should be capable of diagnosing and managing or referring. It seems likely that higher competence as measured with these vignettes would result in health benefits, but as we did not study the association with a health outcome, we cannot be sure.

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A major shortcoming of vignettes, which they share with chart abstraction, is
that they provide little information on personal interaction skills[13] that are
arguably an important dimension of quality of care[28]. There is furthermore
some debate in the literature on whether vignettes might capture knowledge
instead of clinical practice and lead to overestimation of actual practice due to
social desirability bias.[13, 26, 31] Despite this, we found a very low
performance in the two vignettes, which raises serious concerns about the
quality of basic emergency care in the area.

It is a strength of this study that all facilities with births in the surveillance area
and all facilities offering delivery care were included in the health facility
assessment. Knowing the number of births per facility from the surveillance
system enabled us to calculate facility-level workloads, even though information
on deliveries for individual health workers was not available. Not all health
workers trained in deliveries necessarily manage them, and skilled birth
attendants are likely to have other tasks besides managing deliveries.[5]

Only three respondents were doctors and we are thus limited in our ability to
draw conclusions about their competence. In contexts with a shortage of doctors,
these may focus on and thus be more familiar with more complicated
management of obstetric emergencies, such as caesarean delivery, rather than
initial management of obstetric emergencies as assessed in our vignettes.

The health facility data and the surveillance data were collected during different,
subsequent years, in 2010 and 2009, respectively. While the situation regarding
health facilities and births may have changed in the area after data collection, our
findings should still be valid for this time period. It is furthermore possible that
the number of births and/or the number of health workers was different in the
following year, affecting the workload estimates, though this effect is unlikely to
have been substantial. It is also possible that a few deliveries in the study area
were missed by the surveillance. Some facilities managed deliveries of mothers
living outside of the surveillance area. A regional hospital included in the facility
assessment is in particular very likely to have attended deliveries from outside

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that were not included in the surveillance. Therefore, the workload estimates presented here are likely to be underestimates. This regional hospital was included in the analysis because it attends to all referred patients needing tertiary care from the study area, and excluding the regional hospital from the analysis did not change the overall results. Finally, interviewer communication style and respondent perceptions about the assessment might affect competence evaluation. Consistency in interviewing style was maintained throughout the facility assessment as all interviews were conducted by the same person.

Conclusion

A component of high quality of care is ensuring a workload high enough for the maintenance of professional skills, without being so high that staff are overburdened. Optimally, an appropriate workload translates into competence and experience. Collecting facility-level data on workload could allow for a more efficient distribution of limited human resources within a health system.

In low- and middle-income settings, reliable patient records are often missing.[30, 32] Chart abstracts and direct observation of care are resource-consuming[22], and using standardized patients to evaluate emergency care is impossible. Evaluating competence with vignettes in addition to checklist items or chart abstraction could be part of a more comprehensive approach to measuring quality of care. Vignettes provide an opportunity to evaluate whether health worker practice is deficient due to infrastructure or competence[13] to identify poorly performing health worker cadres and target training to them [26] or reconsider task-shifting, and to understand the reasons when increased coverage of interventions does not translate into improved health outcomes.

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Figure legends

Figure 1a. Percent correct in vignettes by respondent cadre in delivery facilities (n=64).
The boxes show the middle 50% of the scores, the vertical lines show the range of scores, the central horizontal line represents the median score and outliers are represented by the dots. Group "others" includes health assistants, health extension workers, traditional birth attendants and ward assistants.

Figure 1b. Mean percent correct in vignettes by respondent cadre (n=64) and by vignette section. Group "others" includes health assistants, health extension workers, trained traditional birth attendants and ward assistants.

Figure 2. Percent correct in vignettes by facility type (n=64). The boxes show the middle 50% of the scores, the vertical lines show the range of scores, the central horizontal line represents the median score and outliers are represented by the dots. Group "clinics" includes clinics, health posts and Community-based Health Planning and Service compounds.

Figure 3. Vignette actions with corresponding health facility assessment checklist items for all facilities combined and by facility type (n=64). Group "clinics" includes clinics, health posts and Community-based Health Planning and Service compounds.
* Administering parenteral anticonvulsants (magnesium sulfate or diazepam) or parenteral antihypertensive drugs (hydralazine, nifedipine or labetalol).
Missing part of bar is proportion of facilities where neither item was available nor action mentioned.

Figure 4. Association between the vignette score and delivery facility workload (n=60).
Three facilities without skilled birth attendants and one facility without skilled birth attendants and deliveries are excluded from the analysis.
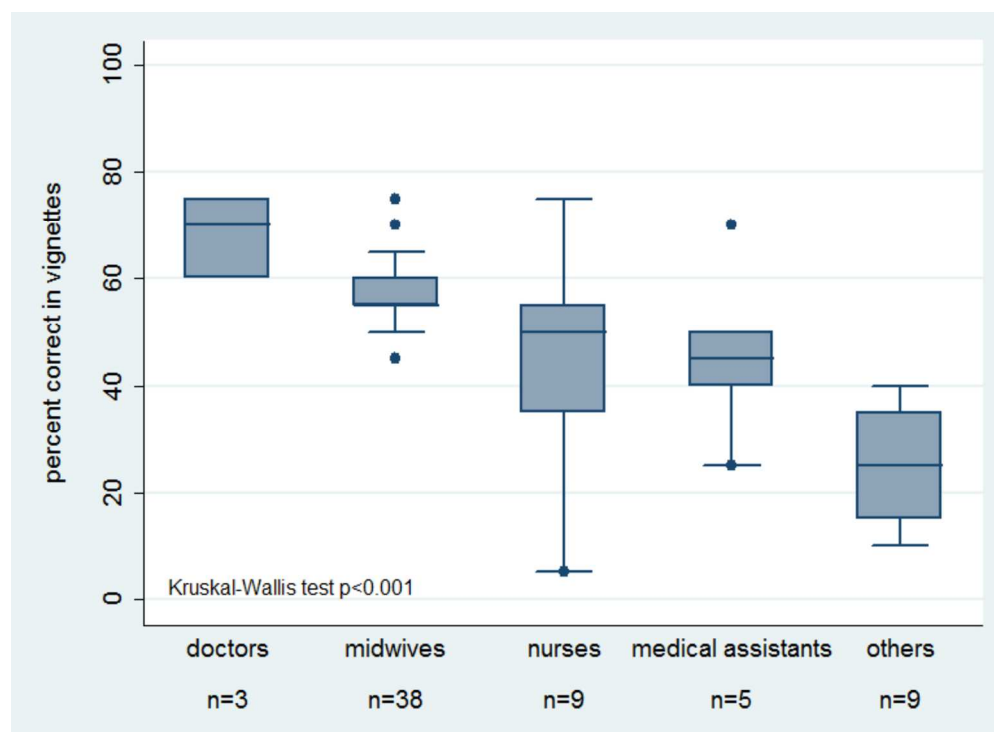
Figure 1a. Percent correct in vignettes by respondent cadre in delivery facilities (n=64). The boxes show the middle 50% of the scores, the vertical lines show the range of scores, the central horizontal line represents the median score and outliers are represented by the dots. Group "others" includes health assistants, health extension workers, traditional birth attendants and ward assistants.
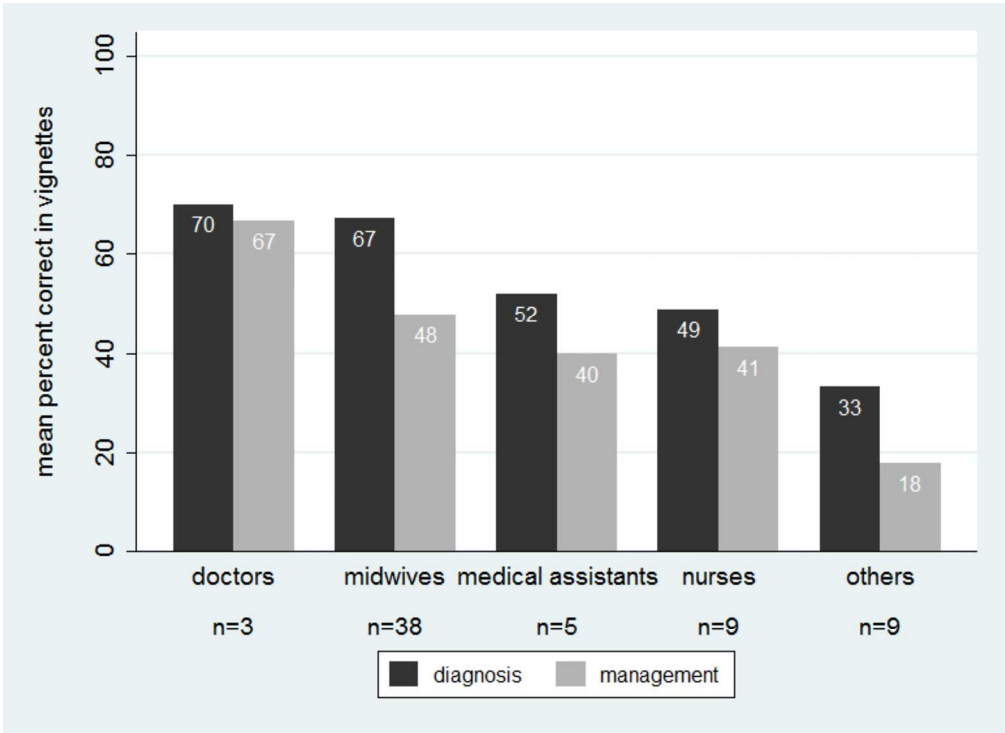173x126mm (300 x 300 DPI)

Figure 1b. Mean percent correct in vignettes by respondent cadre (n=64) and by vignette section. Group "others" includes health assistants, health extension workers, trained traditional birth attendants and ward assistants.
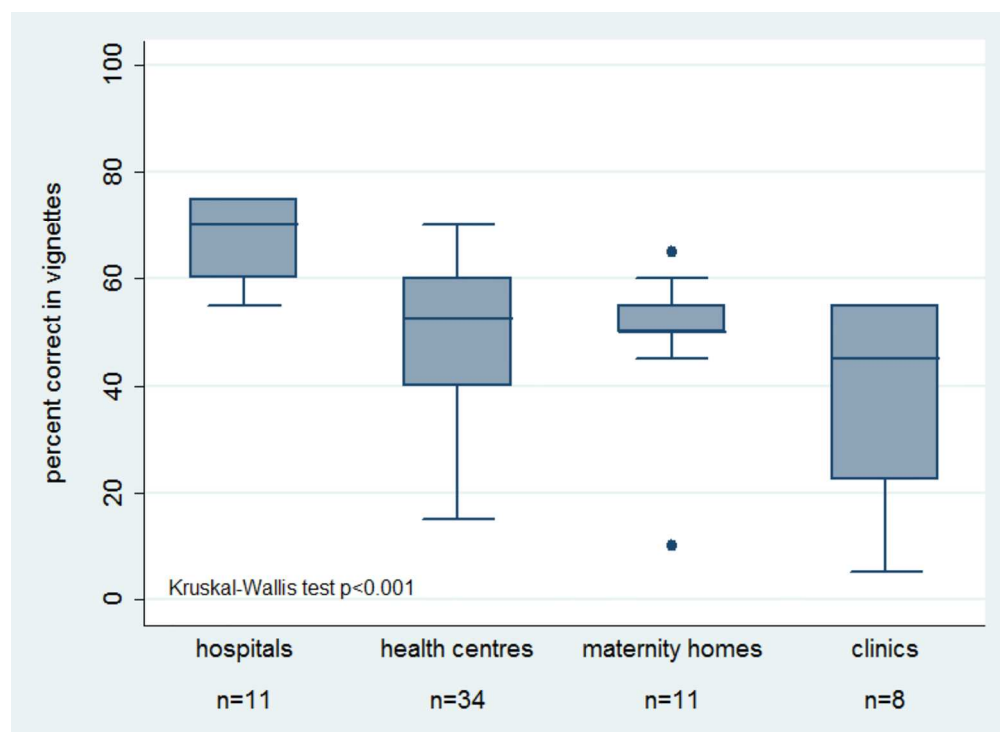173x126mm (300 x 300 DPI)

Figure 2. Percent correct in vignettes by facility type (n=64). The boxes show the middle 50% of the scores, the vertical lines show the range of scores, the central horizontal line represents the median score and outliers are represented by the dots. Group "clinics" includes clinics, health posts and Community-based Health Planning and Service compounds.
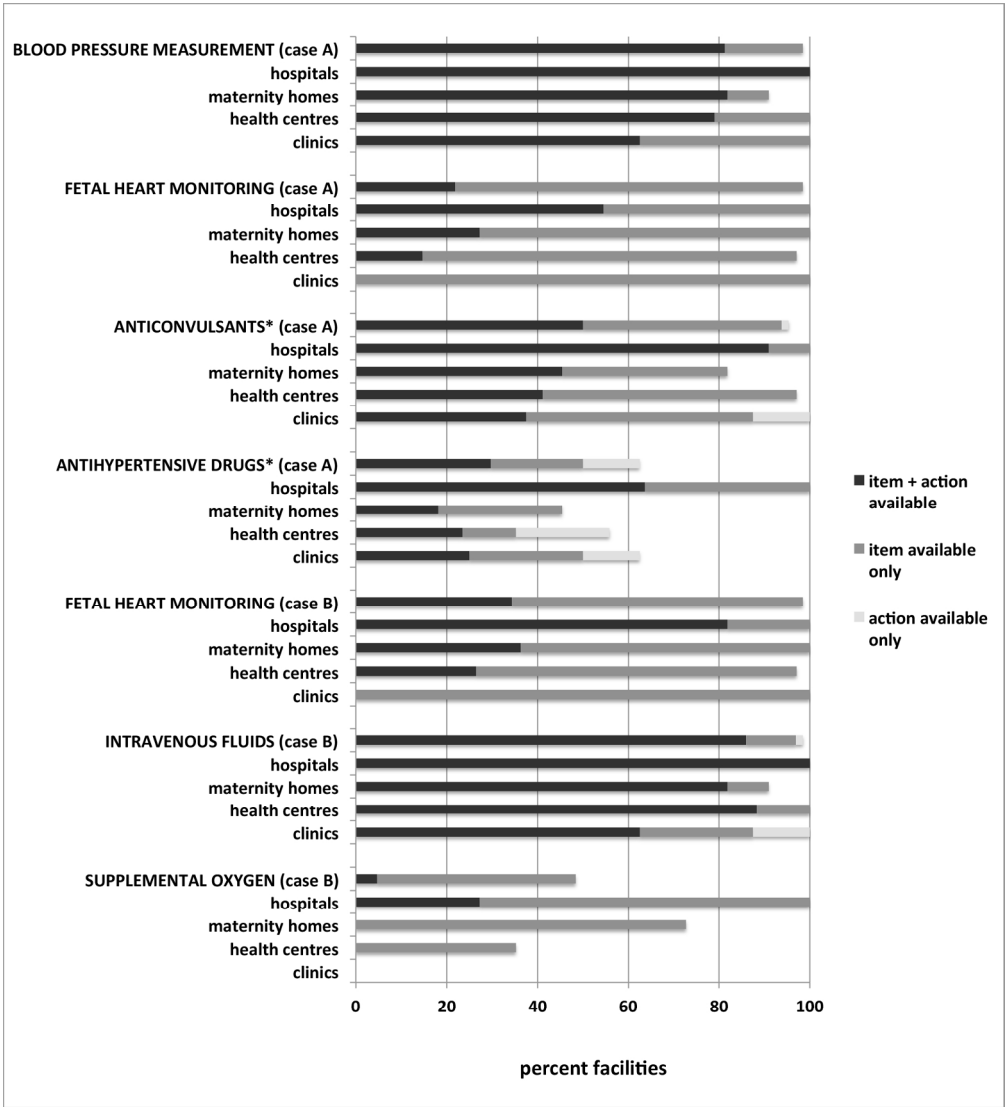173x126mm (300 x 300 DPI)

Figure 3. Vignette actions with corresponding health facility assessment checklist items for all facilities combined and by facility type (n=64). Group "clinics" includes clinics, health posts and Community-based Health Planning and Service compounds.
*Administering parenteral anticonvulsants (magnesium sulfate or diazepam) or parenteral antihypertensive drugs (hydralazine, nifedipine or labetalol).
Missing part of bar is proportion of facilities where neither item was available nor action mentioned.
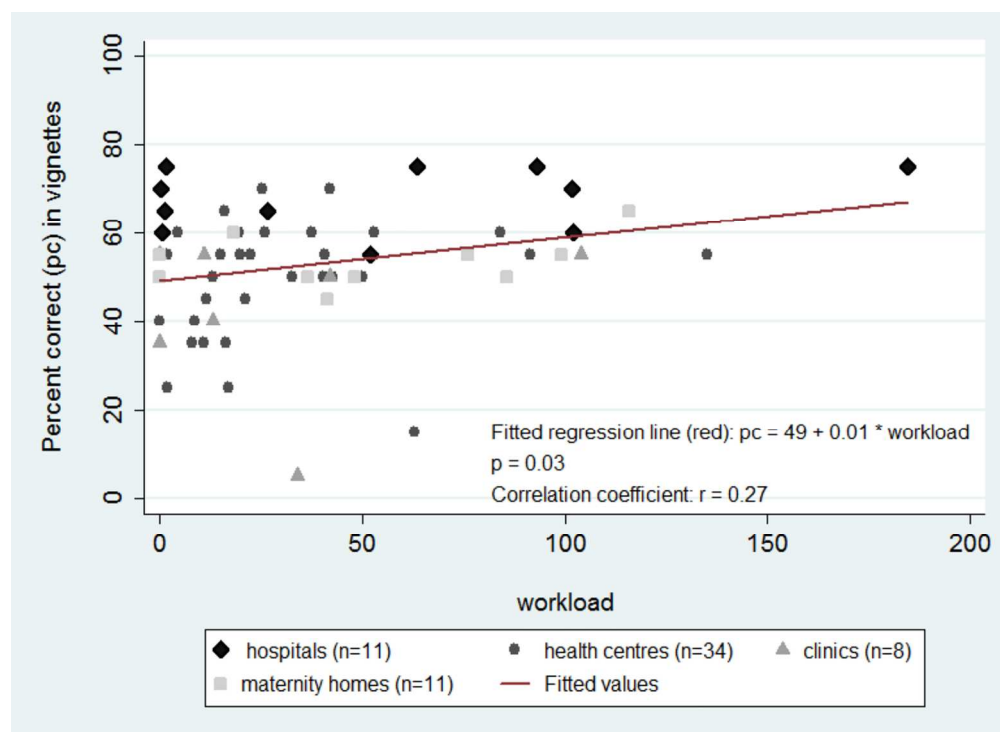173x191mm (300 x 300 DPI)

Figure 4. Association between the vignette score and delivery facility workload (n=60). Three facilities without skilled birth attendants and one facility without skilled birth attendants and deliveries are excluded from the analysis.
173x126mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Where/Done?
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	p. 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p. 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p. 4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	p. 5
Methods			
Study design	4	Present key elements of study design early in the paper	p. 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p. 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	p. 6-7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p. 7-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p. 6-8, 10-11
Bias	9	Describe any efforts to address potential sources of bias	p. 10
Study size	10	Explain how the study size was arrived at	p. 6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p. 7-8, 10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p. 10-11
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	p. 10

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	p. 6-7
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p. 6-7
		(b) Indicate number of participants with missing data for each variable of interest	p. 11 (NONE)
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study—*Report numbers of outcome events or summary measures over time	N/A
		*Case-control study—*Report numbers in each exposure category, or summary measures of exposure	N/A
		*Cross-sectional study—*Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	p. 12-15
		(*b*) Report category boundaries when continuous variables were categorized	p. 12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A

Discussion

Key results	18	Summarise key results with reference to study objectives	p. 16-18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p. 18-20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p.16-20
Generalisability	21	Discuss the generalisability (external validity) of the study results	p. 18-20

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Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p. 21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Table X. Median vignette score (competence) among health workers by cadre, facility type, location and ownership in seven districts of central Brong Ahafo region, Ghana.

	No. of respondents	Diagnosis % (range)	Management % (range)	Total % (range)	Kruskal-Wallis p-value
RESPONDENT CADRE					p<0.001
Doctors	3	70 (60 – 80)	70 (40 – 90)	70 (60 – 75)	
Midwives	38	70 (50 – 80)	50 (30 – 70)	55 (45 – 75)	
Nurses	9	60 (0 – 60)	40 (10 – 90)	50 (5 –75)	
Medical assistants	5	50 (30 – 70)	40 (20 – 70)	45 (25 – 70)	
Others	9	30 (10 – 60)	20 (10 – 30)	25 (10 – 40)	
FACILITY TYPE					p<0.001
Hospitals	11	60 (60 – 80)	70 (40 – 90)	70 (55 – 75)	
Health centres	34	60 (20 – 80)	40 (10 – 70)	53 (15 – 70)	
Maternity homes	11	50 (10 – 70)	50 (10 – 90)	50 (10 – 65)	
Clinics	8	65 (0 – 80)	25 (10 – 40)	45 (5 – 55)	
LOCATION					p=0.01
Urban	14	60 (40 – 80)	60 (30 – 90)	60 (45 – 75)	
Rural	50	60 (0 – 80)	40 (10 – 90)	55 (5 – 75)	
OWNERSHIP					p=0.01
Quasi-public	4	70 (60 – 80)	70 (60 – 90)	75 (60 – 75)	
Private	13	60 (10 – 70)	50 (10 – 90)	55 (10 – 75)	
Public	47	60 (0 – 80)	40 (10 – 70)	55 (5 – 70)	

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Competence of health workers in emergency obstetric care: An assessment using clinical vignettes in Brong Ahafo region, Ghana.

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Competence of health workers in emergency obstetric care: An assessment using clinical vignettes in Brong Ahafo region, Ghana.

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ABSTRACT

Objectives: To assess health worker competence in emergency obstetric care using clinical vignettes, and to link competence to availability of infrastructure in facilities, and to average annual delivery workload in facilities.

Design: Cross-sectional Health Facility Assessment, linked to population-based surveillance data.

Setting: Seven districts in Brong Ahafo region, Ghana.

Participants: Most experienced delivery care providers in all 64 delivery facilities in the seven districts.

Primary outcome measures: Health worker competence in clinical vignette actions by cadre of delivery care provider and by type of facility. Competence was also compared to availability of relevant drugs and equipment and to average annual workload per skilled birth attendant.

Results: Vignette scores were moderate overall, and differed significantly by respondent cadre ranging from a median of 70% correct among doctors, via 55% among midwives to 25% among other cadres such as health assistants and health extension workers (p<0.001). Competence varied significantly by facility type: Hospital respondents, who were mainly doctors and midwives, achieved highest scores (70% correct) and clinic respondents scored lowest (45% correct). There was a lack of inexpensive key drugs and equipment to carry out vignette actions, and more often, lack of competence to use available items in clinical situations. The average annual workload was very unevenly distributed among facilities, ranging from 0 to 184 deliveries per skilled birth attendant; with higher workload associated with higher vignette scores.

Conclusions: Lack of competence might limit clinical practice even more than lack of relevant drugs and equipment. Cadres other than midwives and doctors might not be able to diagnose and manage delivery complications. Checking clinical competence through vignettes in addition to checklist items could contribute to a more comprehensive approach to evaluate quality of care.

Trial registration: http://clinicaltrials.gov NCT00623337.

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ARTICLE SUMMARY

Strengths and limitations of this study

- We used clinical vignettes to assess health worker competence in rural Ghana, choosing two major causes of maternal mortality that independently working delivery care professionals should be able to diagnose and manage.

- While not nationally or longitudinally representative, our health facility assessment included all 64 delivery facilities in seven districts of Brong Ahafo region and captured the best competence available at the time of interview.

- Despite limited sample size and risk of social desirability bias in vignettes, we were able to clearly identify serious shortcomings in health worker competence in the area.

- We used available surveillance data in the districts to estimate births per facility and found an association between competence and workload.

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INTRODUCTION

Skilled birth attendants are crucial to reducing the 289 000 maternal deaths, 2.8 million neonatal deaths and 2.6 million stillbirths that still occur every year.[1-4] Shortage of midwives, especially in remote locations, has led to training of health care professionals other than midwives to manage deliveries.[5] Presence of a skilled attendant at birth is one of the main indicators of progress towards improving outcomes related to pregnancy and childbirth, however, the approach of increasing coverage with birth attendants without assessing their skills has been criticized for ignoring quality.[6]

Measuring quality of care is challenging because quality is a multidimensional concept without a universal definition.[7, 8] Quality of emergency obstetric care in low-and middle-income settings is often evaluated with signal functions that indicate the capacity of a facility to perform certain life-saving interventions.[9] Usually, performance of a signal function within the past three months is verified using patient chart abstracts. Facilities performing a set of six basic signal functions are classified as providing basic emergency obstetric care (BEmOC), and facilities performing emergency surgery (e.g. caesarean delivery) and blood transfusion in addition to the six basic functions are classified as providing comprehensive emergency obstetric care (CEmOC). This well-defined set of key actions targeting the main causes of maternal mortality enables monitoring, evaluating and comparing obstetric care within and between countries.

However, availability of skilled attendants or signal functions may not sufficiently reflect quality of care.[6, 10] In a multi-country survey including 29 countries and 357 large delivery facilities (over 1000 annual deliveries per facility), high coverage with three key signal functions did not translate into reduced maternal mortality.[10] The authors suggest that this might be due to delayed management of emergencies and lack of comprehensive patient care. For example, septic shock requires comprehensive shock management in addition to antibiotic treatment measured by the signal function. Indeed, quality classification based on signal functions assumes that provision of certain

functions indicates that complications were recognized correctly and managed comprehensively without explicitly measuring the overall quality of clinical practice or competence of health workers.

In high-income settings, clinical vignettes have been shown to better reflect physicians' practice than medical record abstracts.[11, 12] They can provide information about procedural changes needed to improve health outcomes and are an inexpensive way of assessing competence, in particular when chart documentation is incomplete.[13] Therefore, vignettes could be an appealing and feasible way to study clinical practice and assess quality of obstetric care in low- and middle-income countries.

In this paper, we assess competence of health workers in delivery facilities in Brong Ahafo region in Ghana using clinical vignettes. We compare competence between health worker cadres and between health facility types. To assess whether clinical practice was limited rather by facility infrastructure or by health worker competence, we compare competence in vignette actions with availability of necessary drugs and equipment. Finally, as a minimum workload and thus experience may be necessary to maintain competence, we study the association between respondent competence and average workload at facilities.

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METHODS

Study design

A cross-sectional health facility assessment was conducted to study health worker competence in emergency obstetric care, and linked to population-based surveillance data on place of birth.

Setting

The study was conducted in all 86 health facilities providing care for mothers and newborns in seven districts in the central Brong Ahafo region of Ghana in October and November 2010: Kintampo North and South, Nkoranza North and South, Tain, Techiman and Wenchi. Several large trials conducted in the area provided reliable health and demographic data relating to mothers and babies.[14-17] The maternal mortality ratio in the area is estimated at 377 per 100 000 pregnancies[15] and neonatal mortality at 31 deaths per 1000 live births[18].

Health facilities

In this analysis, we focused on the 64 facilities in the area providing delivery care as we aimed to study emergency obstetric care. These facilities included one public regional hospital, 10 public, quasi-public (i.e. mission) and private hospitals (level C), 34 public health centres (level B), 11 private maternity homes (level A) and eight small public facilities to which we refer collectively as "clinics" (level A). Among the hospitals, the regional hospital functioned as the referral facility for the area, four were main district hospitals, four were other district hospitals and two were private hospitals. Fourteen facilities were located in urban areas: seven hospitals, one health centre and six maternity homes. The health facilities in the study area have previously been classified in terms of their routine and emergency obstetric care (EmOC) and emergency newborn care (EmNC) performance[19] and in terms of quality of care provided for newborns[20]. The Newhints trial[14] surveillance system collected information on every pregnancy in the study area between November 2008 and December 2009, including the specific delivery facility for facility births.

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Participants

The most experienced provider managing deliveries and newborns present at each facility at the time of the visit was interviewed. These 64 respondents included three doctors, 38 midwives, five medical assistants, nine nurses, and nine belonging to "other" cadres. The group "nurses" included community health nurses, enrolled nurses, public health nurses and staff nurses. The group "others" included health assistants, health extension workers, trained traditional birth attendants and ward assistants. The distribution of respondents in different facility types is presented in Table 1.

Table 1. Respondent cadre by facility type (n=64).					
Facility type	Doctors	Medical assistants	Midwives	Nurses	Others
Hospitals (n=11)	2 (18%)	0	8 (73%)	1 (9%)	0
Health centres (n=34)	1 (3%)	5 (15%)	18 (53%)	4 (12%)	6 (18%)
Clinics (n=8)	0	0	4 (50%)	2 (25%)	2 (25%)
Maternity homes (n=11)	0	0	8 (73%)	2 (18%)	1 (9%)
Total (n=64)	3 (5%)	5 (8%)	38 (59%)	9 (14%)	9 (14%)

Data collection

The health facility assessment, conducted by a physician and a research assistant, included questions regarding antenatal care, routine delivery care, emergency obstetric and neonatal care, referral practices, infrastructure and equipment (including observation of tracer items). Detailed information on staffing was also collected, including numbers of health care professionals managing deliveries, complications and newborns. Clinical vignettes were used to capture competence in managing critical maternal and newborn emergencies.

Vignettes and scores

The first vignette (case A) describes a pregnant woman with signs and symptoms of pre-eclampsia, and the second vignette (case B) represents a case of severe antepartum haemorrhage. Each vignette is divided into a section on diagnosis and a section on management that were read to the respondents separately. Respondents provided open responses and were asked if they would do anything else until they explicitly said no. The interviewer then marked which items from a list of actions were mentioned. The list of vignette actions included a number of

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best practice actions related to diagnosis and initial management of obstetric

emergencies according to WHO Pregnancy, Childbirth, Postpartum and Newborn

Care guidelines[21] for primary level of care and some additional actions, such

as supplemental oxygen administration, that can be performed at a referral-level

facility or in a very well-functioning first-line facility (Table 2).

Table 2. Vignette cases and construction of vignette score.	
Case A. Section 1. A 26-year-old woman who is 7 months pregnant comes in complaining of headaches, blurred vision and epigastric pain and her face looks swollen. In this facility, what would you usually do to establish a diagnosis?	
Vignette action	**Vignette score**
Measure the woman´s blood pressure[†]	+ 1 point if mentioned
Check her urine for protein[†]	+ 1 point if mentioned
Check her reflexes[†]	+ 1 point if mentioned
Check fetal heart rate[†]	+ 1 point if mentioned
Refer to other health facility[†]	+ 1 point if at least one out of two mentioned
Call specialist or respondent is a specialist (i.e. a doctor)	
	Section maximum: 5 points
Case A. Section 2. Upon examination she had a blood pressure of 170/120 mmHg, 3+ protein in her urine and brisk reflexes. How would she be managed at this facility?	
Vignette action	**Vignette score**
Giving antihypertensive drug, e.g. hydralazine, labetalol or nifedipine[†]	+ 1 point if mentioned
Give magnesium sulfate or, if not available, diazepam[†]	+ 1 point if mentioned
Have somebody stay with her all the time in case she starts having seizures[†]	+ 1 point if mentioned
Plan for delivery within the next 24 hours	+ 1 point if at least one out of two mentioned
Refer to other health facility[†]	
	Section maximum: 4 points
Case B. Section 1. A 35-year-old woman who is 8 months pregnant comes to this facility because she has started to bleed heavily vaginally. She has no contractions and does not complain of any pain. In this facility, what would you usually do to establish a diagnosis?	
Vignette action	**Vignette score**
Check the woman´s vital signs[†]	+ 1 point if mentioned
Check fetal heart rate	+ 1 point if mentioned
Perform abdominal examination	+ 1 point if mentioned
Do not perform vaginal examination[†]	+ 1 point if mentioned
Refer to a facility where caesarean delivery can be performed[†]	+ 1 point if at least one out of two mentioned
Call specialist or respondent is a specialist (i.e. a doctor)	
	Section maximum: 5 points
Case B. Section 2. The woman has a feeble pulse at 120 per minute, her systolic blood pressure is 85 and she is pale, sweating and breathing rapidly at 30 breaths per minute. Fetal heart sound is normal. There is no pain on abdominal examination. She is still bleeding vaginally, bright red blood. You suspect placenta praevia and therefore do not perform a vaginal examination. How would such a patient be managed now?	
Vignette action	**Vignette score**
Elevate legs to increase return of blood to the heart[†]	+ 1 point if mentioned
Give intravenous fluids rapidly[†]	+ 1 point if mentioned
Give oxygen by mask or nasal cannula	+ 1 point if at least one out of two mentioned
If oxygen unavailable, refer to a facility where caesarean delivery can be performed	
Perform ultrasound to confirm diagnosis	+ 1 point if at least one out of two mentioned
If ultrasound unavailable, refer to a facility where caesarean delivery can be performed	
Give blood transfusion	+ 1 point if at least one out of two mentioned
If blood transfusion unavailable, refer to a facility where caesarean delivery can be performed	
Prepare for caesarean delivery	+ 1 point if at least one out of two mentioned
Refer to a facility where caesarean delivery can be performed[†]	
	Section maximum: 6 points
Case A and Case B	*Total maximum: 20 points*
[†]*Vignette actions mentioned in WHO Pregnancy, Childbirth, Postpartum and Newborn care.*[21]	

The vignette score was created by assigning one point to each action that could be performed in any kind of facility (i.e. both a first-line facility and a referral facility). For actions performed only or mainly at referral facilities, specifically ultrasound, blood transfusion, supplemental oxygen and caesarean delivery, respondents got one point if the action was not available at the respondent's facility and the respondent said they would refer the woman to a facility capable of performing a caesarean delivery, even if the action was not mentioned specifically (Table 2). Combining both case A and B, the scores for the diagnostic section and management section were 10 points each adding up to an overall maximum score of 20 points. Respondent competence was classified as "high" for >15 points (>75%), "moderate" for 10-15 points (50-75%) and "low" for <10 points (<50%).

As a sensitivity analysis, two alternative vignette scores were created, one that weighed the actions by their clinical importance, and one for which mentioning life-saving key interventions was a requirement. As there were no major differences in results with these alternative scores, we present the simpler approach of assigning one point per action.

Data analysis
We compared median overall vignette scores by respondent cadre using Kruskal-Wallis tests. If the vignette scores measure clinical competence, higher cadres should have higher scores. We also compared median vignette scores by facility type (hospitals, maternity homes, health centres and clinics) using Kruskal-Wallis tests.

To identify whether availability of drugs and equipment or clinical competence were the limiting factor in providing emergency obstetric care through executing vignette actions, we compared six vignette answers with the availability of corresponding items: for example, administering intravenous fluids was compared with availability of infusion sets.

The association between vignette score and workload was analysed using linear regression. Workload was defined as the average number of annual deliveries in a facility in 2009 divided by the number of skilled birth attendants working in that facility. There were altogether 13 692 deliveries in the study area in 2009. We defined a skilled birth attendant (SBA) as a doctor, medical assistant, midwife or nurse trained in managing deliveries. For this analysis, stillbirths were counted as deliveries and multiple births were counted as one delivery. All analyses were performed using Stata 12 (Statacorp. College Station, USA).

Ethical approval and informed consent

Ethical approval for this study was obtained from the London School of Hygiene and Tropical Medicine in the UK, and from the Kintampo Health Research Centre in Ghana. Health professionals included in the health facility assessment signed a written informed consent before the start of the interview. For the Newhints trial, consent was obtained from all women of reproductive age living in the surveillance area (Newhints[14] – clinicaltrials.gov, NCT00623337).

RESULTS

Of the 86 facilities in the study area, 64 (74%) provided delivery care and were included in this analysis. Sixty-nine per cent of the 13 692 deliveries in the area in the year 2009 took place in a health facility.

Competence by health worker cadre

The median total vignette score was 55% of actions mentioned correctly with a range from 5% to 75%. For 28% of all respondents, competence was classified as low (<50%) and none of the respondents achieved a high score (>75%). The vignette score differed significantly between respondent cadres, showing a clear trend (Figure 1a): The three doctors had the highest scores with a median of 70% (range 60-75%), the 38 midwives scored a median of 55%, the nine nurses 50%, five medical assistants 45% and the nine other cadres 25%. A doctor, one public health nurse and two midwives scored the highest points overall (75%). Doctors performed equally well in the sections relating to diagnosis (70%) and management (67%), and they performed better in both sections compared to other cadres (Figure 1b). Midwives were the second best cadre with 67% correct in diagnosis and 48% in management. Medical assistants had a moderate competence in diagnosis (52%) but low competence in management (40%). Their results were similar compared with nurses who had 49% in diagnosis and 41% in management. The other respondents scored a low percentage in diagnosis (33%) and in management (18%).

Competence by type of delivery facility

Higher vignette scores were strongly associated with the type of delivery facility (p<0.001, Figure 2). Respondents in the 11 hospitals achieved the highest score with a median of 70% (range 55-75%); respondents were eight midwives, one nurse and two doctors. Maternity home and health centre respondents were mainly midwives and both had a similar level of vignette competence with a median of 53% in health centres and 50% in maternity homes. Health workers in clinics, also mainly midwives, scored lowest in the vignettes with a median score of 45% (range 5-55%). (Figure 2, Table 1)

Respondents in quasi-public facilities had a higher vignette competence with a median of 75% compared to private and public facilities where the median score was 55% (p=0.01). Competence varied more in public facilities (range 5-70%) and in private facilities (10-75%) compared to quasi-public facilities (60-75%). Health workers in urban facilities were more competent as judged by vignette scores (median 60%, range 45-75%) compared to rural respondents (median 55%, range 5-75%) (p=0.01).

Infrastructure and competence

Both lack of necessary drugs and equipment, and lack of knowledge on how and when to use them in practice, would limit diagnosis and management of a woman presenting with pre-eclampsia or antepartum haemorrhage in facilities. Our comparison revealed that the limiting factor in the majority of cases was competence (Figure 3): In all facility types, required drugs and equipment were more frequently available than the actions were mentioned in the vignettes, with one exception; administering antihypertensive drugs was mentioned more frequently (44% of health centres) than they were available (35% of health centres). All hospitals had all six items available and hospital respondents were more likely to mention the corresponding actions in the vignettes compared to respondents of other facility types.

Of the drugs and equipment studied with their corresponding vignette actions, the sphygmomanometer to measure blood pressure, intravenous fluids with infusion sets, and fetoscope or an electronic fetal heart monitor were the most frequently available equipment items present in nearly all facilities (≥ 97%). Blood pressure measurement and administering intravenous fluids were also mentioned frequently, but surprisingly only 22% of facility respondents mentioned assessing fetal distress in the vignette featuring a pre-eclamptic woman (case A). In hospitals, monitoring fetal heart sounds in case A was mentioned approximately twice as often (55%) as in maternity homes (27%) and nearly four times as often as in health centres (15%). Assessing fetal distress of a woman with antepartum haemorrhage was slightly more common and mentioned by 34% of all respondents. Although all clinics had a fetoscope

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available, none of the clinic staff mentioned during the vignettes that they would apply it in practice.

Anticonvulsants were available in 94% of all facilities, but in the pre-eclampsia vignette, they were only mentioned by 50% of respondents in facilities where it was available. While 91% of hospital respondents reported they would administer anticonvulsants, only 41% of respondents in health centres and 45% in maternity homes answered that they would have administered these to the pre-eclamptic woman. Half of all clinics and 45% of maternity homes had antihypertensive drugs available and their use was mentioned in the vignette by 25% of clinics and 18% of maternity homes where these items were available. Oxygen was available in 48% of all facilities, but only 5% of all respondents mentioned administering supplemental oxygen to a woman presenting with severe antepartum haemorrhage. No clinic had oxygen available, but three quarters of maternity homes and a third of health centres had oxygen cylinders, and all hospitals. However, none of the health workers interviewed in maternity homes and health centres, and only 27% of hospital respondents would have administered supplemental oxygen to a woman presenting with antepartum haemorrhage.

Workload and competence

The overall number of skilled birth attendants working in facilities ranged from 0-2 in clinics, 0-4 in maternity homes, 0-8 in health centres and 3-53 in hospitals. The overall median frequency of deliveries per SBA per year was 26 (range 0-184) and the mean was 39 deliveries per SBA.

The highest workload was in hospitals with a median of 52 deliveries annually per SBA. The facility that managed the highest workload was a hospital with a total of 2 398 deliveries in the year 2009 and 13 SBAs, resulting in 184 deliveries per SBA. The workload was unevenly distributed between hospitals: In four of the eleven hospitals, each SBA attended on average to less than two deliveries per year and in three hospitals the delivery workload was more than 100 deliveries per SBA per year. Maternity homes had the second highest workload

with a median of 45 deliveries annually per SBA, followed by health centres (21 deliveries per SBA) and clinics (13 deliveries per SBA). Workload in clinics ranged from 0 to 42 deliveries per SBA, with one outlier, a rural clinic with one SBA and 104 deliveries in 2009. The second highest delivery workload overall was in a health centre with one SBA only and 135 deliveries. A higher delivery workload in a facility was associated with a higher competence as measured with the vignettes (p=0.03, Figure 4).

Five of the 64 delivery facilities employed SBAs but did not manage deliveries during the surveillance period, and three delivery facilities employed no SBAs but managed altogether 57 deliveries. If all 13 692 deliveries in the surveillance data in 2009 had taken place in the 64 delivery facilities, managed by the 273 SBAs (or by the 189 midwives) employed there, the average delivery workload would have been 50 deliveries per SBA (or 72 deliveries per midwife).

DISCUSSION

We found that competence in first-line management of obstetric emergencies as measured by two clinical vignettes varied markedly by cadre and facility type. The two cadres with most training in obstetric care - doctors and midwives - scored highest in the vignettes, as expected. However, even doctors and midwives were classified as only moderately competent. The association of higher vignette score with facility type likely reflects the availability of more experienced and skilled staff in hospitals compared to smaller facilities. The better competence of health workers in urban areas and in quasi-public facilities is in line with most urban facilities and all four quasi-public facilities being hospitals. Despite the moderate overall performance of health professionals, these expected findings support the validity of the two vignettes in assessing competence of delivery staff.

It has been suggested that clinical vignettes are a particularly useful way of assessing quality of clinical practice in low-and middle-income countries because chart abstraction is time-consuming and can be unreliable even in high-income countries.[22, 23] Clinical vignettes have been used in low-and middle-income settings in a variety of ways.[20, 23-27] For instance, quality of care for diarrhoea, tuberculosis and prenatal care was evaluated using vignettes in a cross-country study including 300 physicians in five middle-income countries – China, the Philippines, El Salvador, India and Mexico.[26] In that study, the average quality of care was similarly low across countries, and there was high variation of performance within countries with some exceptionally well-performing physicians. The authors concluded that availability of resources is not the only or even an important predictor of competence, and that improvements in quality could be achieved by targeting poor performers.

Comparison of vignette actions and necessary drugs and equipment in our study illustrated the lack of these inexpensive key items and lack of competence to use these in clinical situations. In many cases when the items were available, they were still not mentioned in the vignettes when they should have been,

suggesting that competence was the limiting factor. For example, while nearly all facilities had equipment to monitor fetal distress, it was rarely mentioned in the vignettes despite the fact that use of a fetoscope is relatively straightforward, there are no additional costs associated with its use and assessing fetal distress should be among the first examinations of a woman presenting with an obstetric emergency. Another striking finding was how infrequently oxygen was mentioned in the vignettes even when it was available; Oxygen was available in 48% of all facilities, but only 5% of respondents mentioned administering oxygen to the woman in bleeding shock. This example represents a double gap: a resource gap and a competence gap. In most instances the larger gap was in competence, which reveals a major missed opportunity.

Human resource shortages have been identified as a large barrier to delivery care in Ghana.[5] The mean yearly workload found in this study (39 deliveries per SBA) is similar to what has been reported for other sub-Saharan African countries.[28] Our estimates for workload are lower than the numbers reported by Witter et al. from the central and Volta regions of Ghana in 2005 where midwives working in public facilities were reported to carry out on average 19 deliveries weekly (corresponding to 988 annually) and midwives in private facilities attended to four deliveries weekly (208 annually).[29] It is possible that there are regional variations in workload within Ghana. Alternatively, the discrepancy may be due to methodological differences; the study by Witter et al. used self-reported data whereas we calculated the number of births per attendant by dividing the number of facility births from a surveillance system through the number of SBAs taken from a health facility assessment. If several providers attend to one delivery, the first method is going to give higher workloads.

The workload was unevenly distributed between facilities in our study area, even among hospitals. Except for one outlier with 104 yearly deliveries, the workload was very low in clinics; SBAs in clinics managed only a median of one delivery every 28 days. In five facilities, health professionals trained to manage deliveries did not attend to any deliveries during the one-year period. On the other extreme, there was a facility with 184 births per SBA, or 343 births per

midwife in a year, and three facilities – a maternity home, a clinic and a health centre – with only one SBA and more than a hundred deliveries in a year. This uneven distribution of deliveries among SBAs is likely to lead to worse quality of care as some SBAs are overburdened while others manage too few deliveries to maintain their professional competence. At the same time, nearly one in three women in the study area still delivered without SBA outside a health facility.

This study has several strengths and limitations. It was conducted in the Brong Ahafo Region in central Ghana and results can thus not be easily generalized to the whole of Ghana. However, the study area is large, comprising seven districts, and has a very similar maternal mortality ratio and facility delivery rates as in Ghana as a whole.[30]

Each of the facilities was visited only once during daytime, interviewing the most experienced member of staff present at the time. Therefore, the facility assessment is a snapshot of the quality of care provided in each facility, and it may have been better or worse at other points in time. In fact, in 21 facilities (33%) there were other employees registered belonging to a cadre with higher average vignette score than the respondent cadre. However, had the interviewer been a woman in labour, the respondent would have attended to her, and this would have been the quality of care available for her. Our evaluation thus captured the best competence available in each facility at the time of the interview.

While they do not provide information about routine care or other emergencies, our vignettes represent two major causes of maternal mortality that all health workers in charge of deliveries and all delivery facilities should be capable of diagnosing and managing or referring. It seems likely that higher competence as measured with these vignettes would result in health benefits, but as we did not study the association with a health outcome, we cannot be sure.

A major shortcoming of vignettes, which they share with chart abstraction, is that they provide little information on personal interaction skills[13] that are

arguably an important dimension of quality of care[28]. There is furthermore some debate in the literature on whether vignettes might capture knowledge instead of clinical practice and lead to overestimation of actual practice due to social desirability bias.[13, 26, 31] Despite this, we found a very low performance in the two vignettes, which raises serious concerns about the quality of basic emergency care in the area.

It is a strength of this study that all facilities with births in the surveillance area and all facilities offering delivery care were included in the health facility assessment. Knowing the number of births per facility from the surveillance system enabled us to calculate facility-level workloads, even though information on deliveries for individual health workers was not available. Not all health workers trained in deliveries necessarily manage them, and skilled birth attendants are likely to have other tasks besides managing deliveries.[5]

Only three respondents were doctors and we are thus limited in our ability to draw conclusions about their competence. In contexts with a shortage of doctors, these may focus on and thus be more familiar with more complicated management of obstetric emergencies, such as caesarean delivery, rather than initial management of obstetric emergencies as assessed in our vignettes.

The health facility data and the surveillance data were collected during different, subsequent years, in 2010 and 2009, respectively. While the situation regarding health facilities and births may have changed in the area after data collection, our findings should still be valid for this time period. It is furthermore possible that the number of births and/or the number of health workers was different in the following year, affecting the workload estimates, though this effect is unlikely to have been substantial. It is also possible that a few deliveries in the study area were missed by the surveillance. Some facilities managed deliveries of mothers living outside of the surveillance area. A regional hospital included in the facility assessment is in particular very likely to have attended deliveries from outside that were not included in the surveillance. Therefore, the workload estimates presented here are likely to be underestimates. This regional hospital was

included in the analysis because it attends to all referred patients needing tertiary care from the study area, and excluding the regional hospital from the analysis did not change the overall results. Finally, interviewer communication style and respondent perceptions about the assessment might affect competence evaluation. Consistency in interviewing style was maintained throughout the facility assessment as all interviews were conducted by the same person.

Conclusion

Our results suggest that health workers other than midwives and doctors might not be able to provide sufficient quality of emergency obstetric care. In parallel to increasing the availability of equipment and drugs, it must be ensured that health workers are able to use them correctly in practice. An appropriate workload translates into experience and competence; it must be high enough for the maintenance of professional skills, without being so high that staff are overburdened. Collecting facility-level data on workload could allow for a more efficient distribution of limited human resources within a health system and improve quality of care. Vignettes provide an opportunity to evaluate whether health worker practice is deficient due to infrastructure or competence[13] to identify poorly performing health worker cadres and target training to them [26] or reconsider task-shifting, and to understand the reasons when increased coverage of interventions does not translate into improved health outcomes. Evaluating competence with vignettes in addition to checklist items or chart abstraction could be part of a more comprehensive approach to measuring quality of care.

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Competing interests: None.

Ethics approval: Provided by the London School of Hygiene and Tropical Medicine in the UK, and the Kintampo Health Research Centre in Ghana.

Provenance and peer review: Not commissioned; externally peer-reviewed.

Data sharing statement: No additional data are available.

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Figure legends

Figure 1a. Percent correct in vignettes by respondent cadre in delivery facilities (n=64).
The boxes show the middle 50% of the scores, the vertical lines show the range of scores, the central horizontal line represents the median score and outliers are represented by the dots. Group "others" includes health assistants, health extension workers, traditional birth attendants and ward assistants.

Figure 1b. Mean percent correct in vignettes by respondent cadre (n=64) and by vignette section. Group "others" includes health assistants, health extension workers, trained traditional birth attendants and ward assistants.

Figure 2. Percent correct in vignettes by facility type (n=64). The boxes show the middle 50% of the scores, the vertical lines show the range of scores, the central horizontal line represents the median score and outliers are represented by the dots. Group "clinics" includes clinics, health posts and Community-based Health Planning and Service compounds.

Figure 3. Vignette actions with corresponding health facility assessment checklist items for all facilities combined and by facility type (n=64). Group "clinics" includes clinics, health posts and Community-based Health Planning and Service compounds.
* Administering parenteral anticonvulsants (magnesium sulfate or diazepam) or parenteral antihypertensive drugs (hydralazine, nifedipine or labetalol).
Missing part of bar is proportion of facilities where neither item was available nor action mentioned.

Figure 4. Association between the vignette score and delivery facility workload (n=60).
Three facilities without skilled birth attendants and one facility without skilled birth attendants and deliveries are excluded from the analysis.
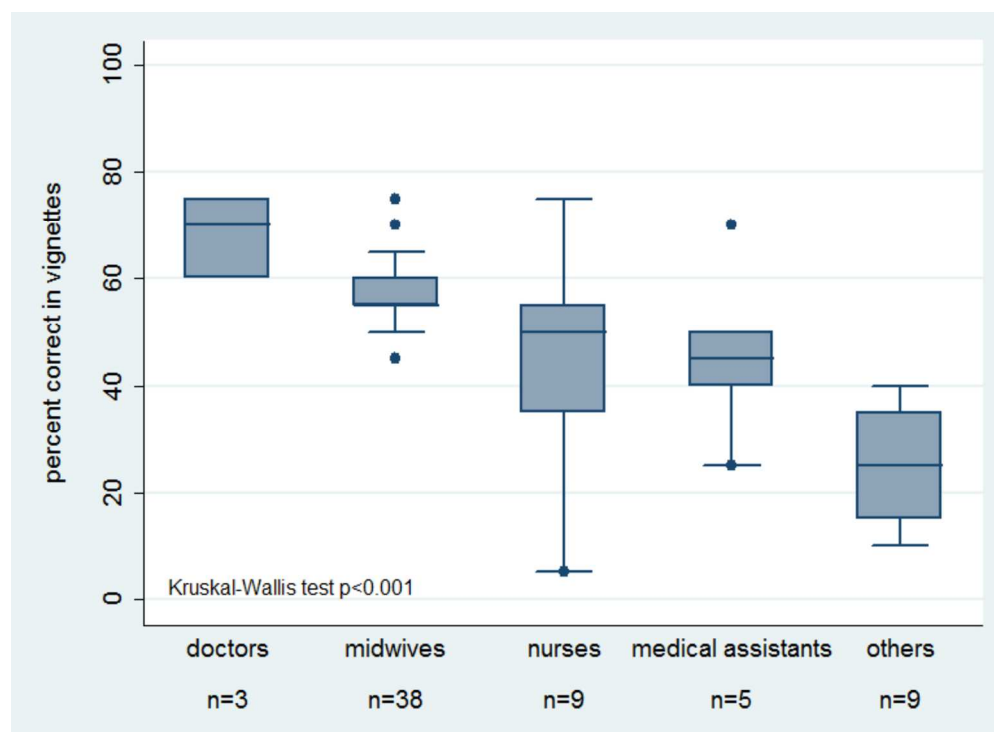
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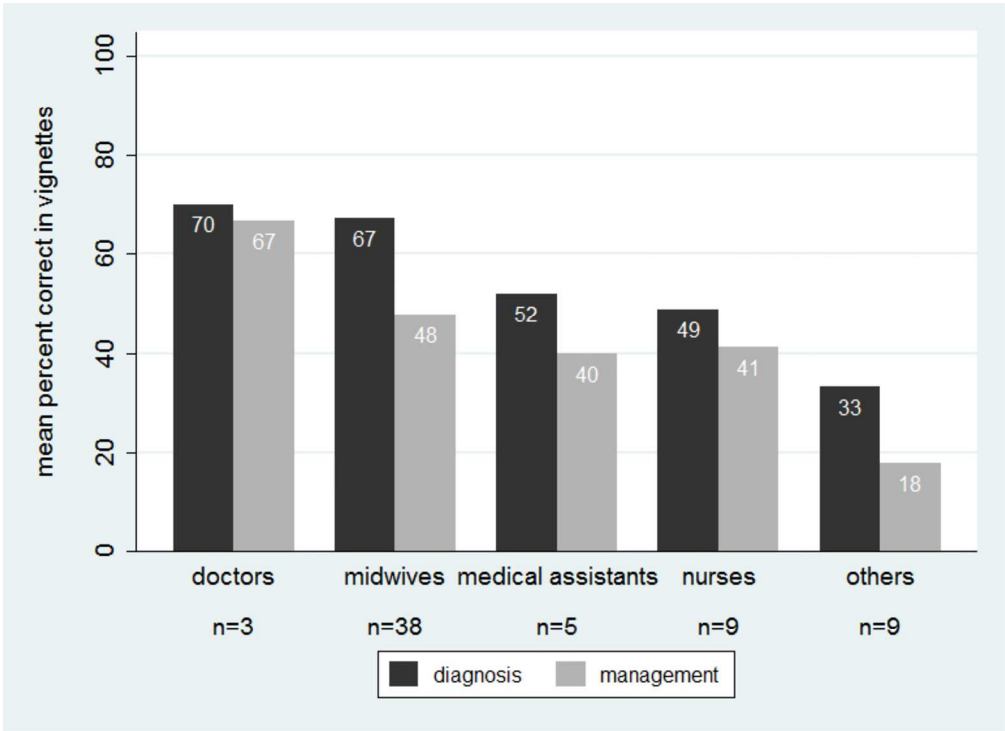173x126mm (300 x 300 DPI)

Figure 1b. Mean percent correct in vignettes by respondent cadre (n=64) and by vignette section. Group "others" includes health assistants, health extension workers, trained traditional birth attendants and ward assistants.
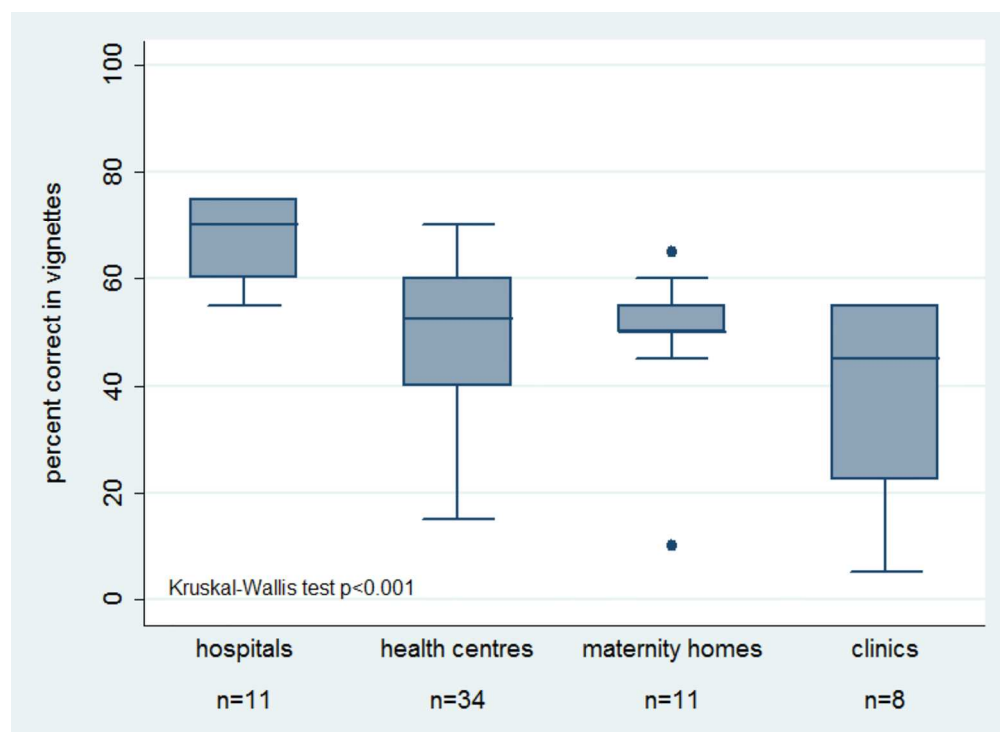173x126mm (300 x 300 DPI)

Figure 2. Percent correct in vignettes by facility type (n=64). The boxes show the middle 50% of the scores, the vertical lines show the range of scores, the central horizontal line represents the median score and outliers are represented by the dots. Group "clinics" includes clinics, health posts and Community-based Health Planning and Service compounds.
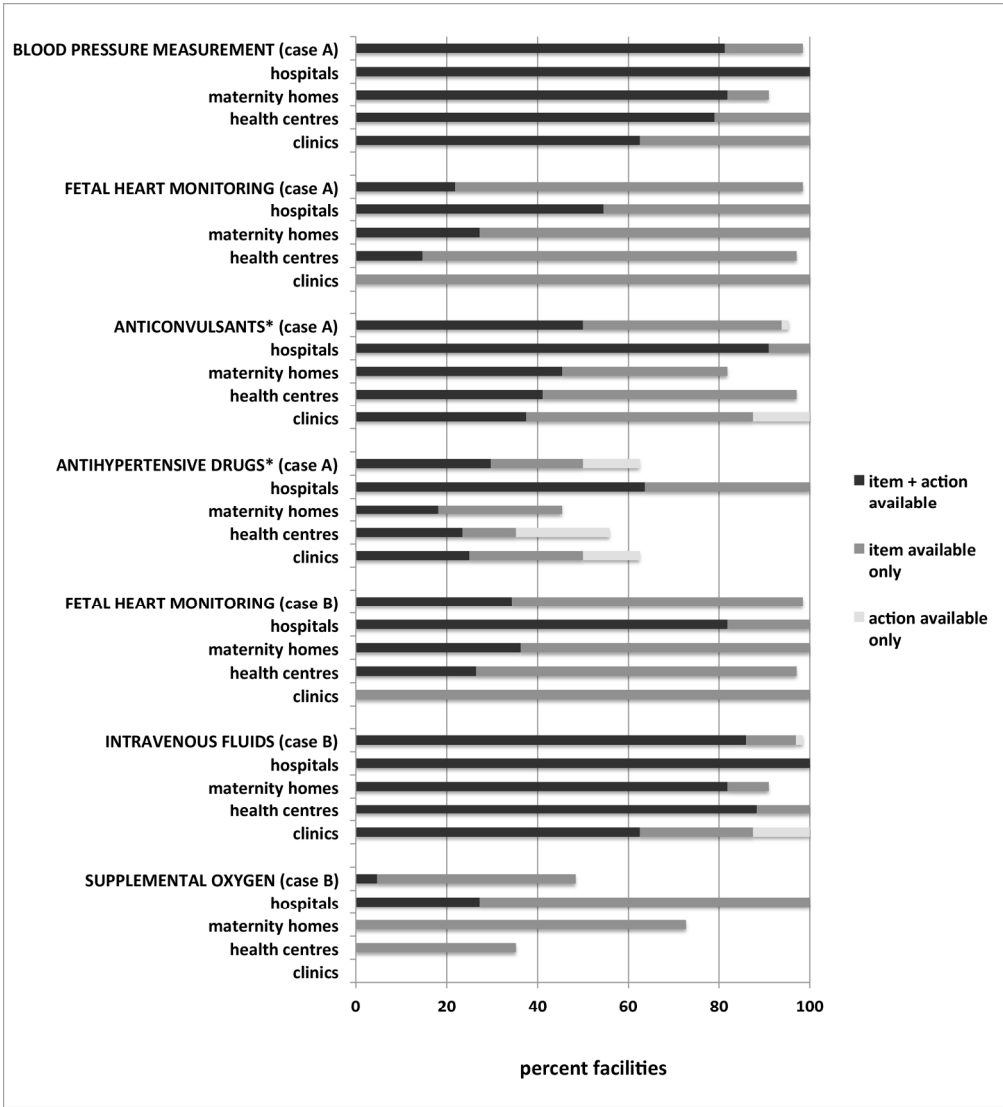173x126mm (300 x 300 DPI)

Figure 3. Vignette actions with corresponding health facility assessment checklist items for all facilities combined and by facility type (n=64). Group "clinics" includes clinics, health posts and Community-based Health Planning and Service compounds.
* Administering parenteral anticonvulsants (magnesium sulfate or diazepam) or parenteral antihypertensive drugs (hydralazine, nifedipine or labetalol).
Missing part of bar is proportion of facilities where neither item was available nor action mentioned.
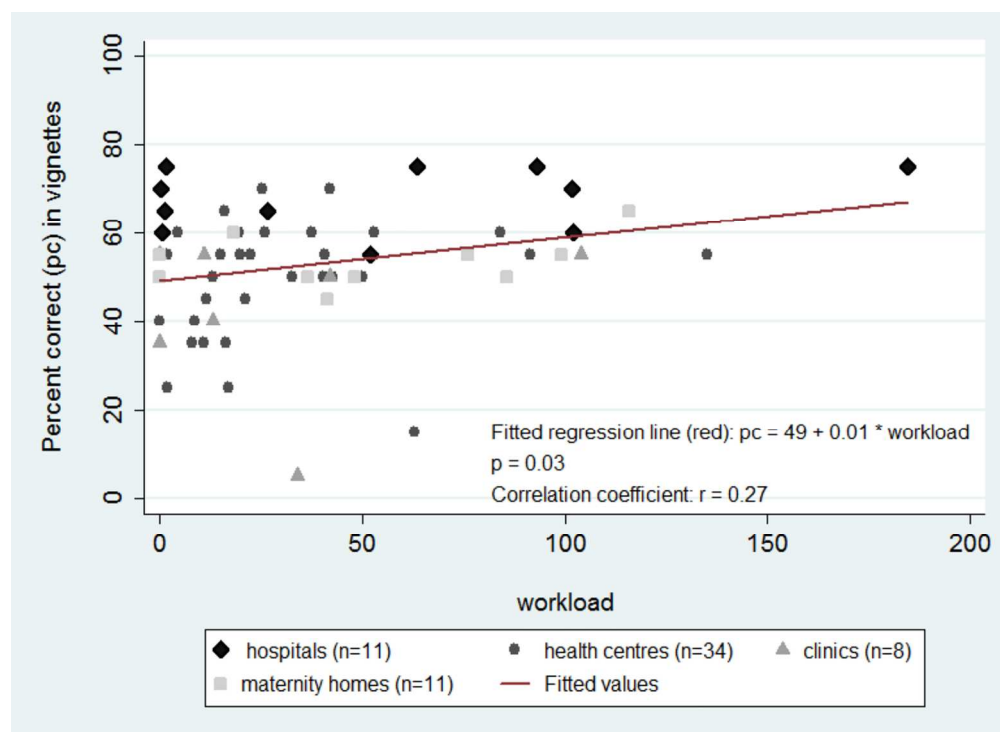173x191mm (300 x 300 DPI)

Figure 4. Association between the vignette score and delivery facility workload (n=60). Three facilities without skilled birth attendants and one facility without skilled birth attendants and deliveries are excluded from the analysis.
173x126mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Where/Done?
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	p. 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	p. 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	p. 4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	p. 5
Methods			
Study design	4	Present key elements of study design early in the paper	p. 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	p. 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	p. 6-7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	p. 7-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	p. 6-8, 10-11
Bias	9	Describe any efforts to address potential sources of bias	p. 10
Study size	10	Explain how the study size was arrived at	p. 6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	p. 7-8, 10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	p. 10-11
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	p. 10

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	p. 6-7
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	p. 6-7
		(b) Indicate number of participants with missing data for each variable of interest	p. 11 (NONE)
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		*Case-control study—*Report numbers in each exposure category, or summary measures of exposure	N/A
		*Cross-sectional study—*Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	p. 12-15
		(*b*) Report category boundaries when continuous variables were categorized	p. 12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	p. 16-18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	p. 18-20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	p.16-20
Generalisability	21	Discuss the generalisability (external validity) of the study results	p. 18-20

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	p. 21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.