**Author’s response to reviews**

**Title:** Referral patterns through the lens of health facility readiness to manage obstetric complications: national facility-based results from Ghana

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Referral patterns through the lens of health facility readiness to manage obstetric complications: national facility-based results from Ghana

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Dear Ms. Vidler,

Your comments and those of the two external reviewers were thoughtful and will improve the paper. I hope I have incorporated suggestions to everyone’s satisfaction. Please find my detailed responses to the reviewers’ specific comments.
Reviewer #1: There are times in peer-reviewed literature when the obvious needs to be supported by rigorous methodology. I feel like this is one of those times. The authors report that referrals are common in lower-level facilities, but that district hospitals can manage most complications that are referred to them. They highlight that they are capable of providing care beyond their perceived preparedness. The authors also clearly document that most hospitals are not ready to manage serious obstetric emergencies.

This paper will be valuable to policy makers in Ghana and countries considering making improvements to similar systems for emergency referral. They highlight important gaps in policy implementation for programs such as the NAS and NHIS.

I am concerned that they only captured a 9% complication rate in their study sample. I typically see a 15% complication and referral rate cited which comes from WHO, UNICEF, UNFPA, World Bank. Trends in maternal mortality: 1990 to 2010. Geneva: WHO; 2012. http://www.unfpa.org/public/home/publications/ pid/10728. Accessed April 3, 2014. I recognize this paper is a bit dated and based on projections rather than methodical counting as done in this study. The authors state that their methodology would tend to over-count referrals, but the discrepancy raises questions that perhaps some referrals were missed.

Authors’ response: The 9% complication rate is based on the 9 complications in Table 1; it does not include an additional 3% of admissions who were categorized as having “other direct obstetric complications.” Furthermore, another 45,501 obstetric admissions were recorded as having an indirect complication (malaria, HIV/AIDS-related, severe anemia, sickle cell anemia, hepatitis and “other indirect complications”). In total, about 23% of admissions had some complication. We have added a footnote to the table and text in the Results section that includes this additional information on the direct obstetric complications. However, we agree that the counting and classifying of complications are limitations to the data and have stated as such in the Discussion.

I would like for the authors to specify how the facility readiness was assessed. They state on line 16 page 6 that data collection instruments were used. It is not clear whether data collectors visited each hospital and directly observed the items on the data collection instruments or if hospital administrators filled out the instrument. It is commendable that they made an effort to ensure that a person capable of using the resources related to a signal function was present.
Authors’ response: We have clarified in the text that data collectors visited each health facility. While some items were observed, the majority of the items that were part of the inventory of drugs, equipment and supplies were answered by staff who worked in the facility, usually working in the maternity, operating theatre, or the pharmacy (in the case of medications). Hospital administrators did not fill out the data collection instruments.

This paper highlights two important points: the lack of complete preparedness of the top-level facilities, and the lack of communication capabilities in several high-volume referral centers.

Reviewer #2: This is an interesting paper that describes referral patterns and facility readiness to receive and treat high risk obstetric patients in 977 health facilities in Ghana. The results find that the lowest level facilities are least prepared to treat obstetric complications and were the most likely to refer patients. Higher level facilities were more prepared, albeit not completely, to treat complications and least likely to refer. District level facilities provided the bulk of obstetric care in Ghana. Several additional details could strengthen the manuscript: Geographical mapping of the facility types and numbers, by region; disaggregation of district and regional hospitals in the results (Figure 3); and the addition of maternal mortality data, if available.

Authors’ response: If the reviewer and the editor feel strongly about the geographical mapping, it will delay our response requested by December 7. I did disaggregate district and teaching/regional hospitals in Figure 3 although this information is also in Table 2. If length of the manuscript or the number of figures and tables is an issue, we could consider dropping Figure 3 all together and focus the readers’ attention to Table 2 (or vice versa). I have added to Table 1 the number of direct maternal deaths (based on the 9 complications) at the national level as well as the disaggregated deaths by the different causes of death. We did not collect information on deaths among referrals.

Abstract:

Page 2, line 12: Results: Replace "tended to refer nearly all" with "were more likely to refer"

Authors’ response: substitution made.
Page 2, line 21: What is meant by "Improving conditions for referral"?

Authors’ response: see modifications in track changes to the Abstract discussion.

Background:

Page 4, line 8-9: The sentence needs clarification. Who makes the "local driven decision" and what is the "desired distribution" of referrals?

Authors’ response: We have added text to this paragraph that elaborates on some of the factors that influence local decision-making. A major driver is government policy and action. I don’t think there is a “desired distribution of referrals” except that all women and newborns in need of higher levels of care should have access to that care.

Page 4, line 9-11: How does knowing where deliveries occur inform the referral system design? Explain what is meant by "different levels", perhaps, different types of facilities.

Authors’ response: We have added examples of how where deliveries take place might inform the design of the referral system. “Different levels” does refer to levels of care and the types of facilities that provide that care.

Page 4, line 17-18: Unlike high volume facilities in high income countries (as referenced), high volume facilities (such as referral and teaching hospitals) in Ghana do not have better maternal and newborn outcomes. A number of publications have shown that referral and teaching hospitals in Ghana have maternal mortality rates that are double to triple the national average.

Authors’ response: By adding the maternal death data, we also show that teaching/regional hospitals have at least double the rate of maternal mortality found in district hospitals.

Page 5, line 13: This sentence is unclear, are the authors saying that there are 128 ambulance stations in Accra, or are these distributed across other major cities?
Authors’ response: The 128 ambulance stations are scattered throughout the country, largely in the capital cities. Hopefully, the sentence is clearer.

Page 5, line 21-23: This needs to be updated. The institutional delivery rate is now even higher than quoted. Also, Ghana has done better in getting patients to the hospital for delivery, but the does not ensure hospital preparedness and the quality of care.

Authors’ response: We have added a more recent reference (the 2017 Maternal Mortality Survey) that shows that overall and rural institutional delivery rates have increased since the 2014 DHS.

Methods:

Page 6, line 11-14: say the based on 1 to 5 deliveries per month, not "the number of deliveries attended". Also, line 14 delete "attended" and rephrase to "we selected only those facilities that had an average of 5 or more deliveries per month". Also, were certain geographic regions excluded?

Authors’ response: We hope this section has been clarified (see track changes) – this was obviously a problem since 2 of the 3 reviewers/editors found the original text problematic.

Page 6, line 16: Delete "40+" and say "used in over 40 countries?"

Authors’ response: Substitution made.

Page 6, line 22: April 2009 to May 2010 is a 14 month period, not 12.

Authors’ response: Thank you, we’ve corrected this error (May should have been March).
Page 7, line 3-6: Were complications counted more than once? For example, ectopic pregnancy is one of the causes of antepartum hemorrhage. Retained placenta is one of the causes of postpartum hemorrhage. Also, did abortion include both spontaneous and induced? Does antepartum hemorrhage and postpartum hemorrhage represent one or two complications? How are the complications defined?

Authors’ response: We did not count complications but women. APH was restricted to placental abruption and placenta praevia; ectopic pregnancy was treated as a separate complication. As stated in the revised text (track changes), if the data collectors encountered a woman with more than 1 complication, they were instructed to choose the most life-threatening complication. I have also added the reference for the operational definitions of the major direct obstetric complications. Data collectors had these definitions in their manuals. The revised text also clarifies how abortion was defined.

Page 7, line 10-12: This sentence is unclear. Wouldn't data have been gathered from different sources and then pooled? Was there duplication of counting? It seems strange that numerator exceeds the denominator.

Authors’ response: I have tried to make this sentence clearer and data could have been gathered from more than one source. We believe that much of the discrepancy between the two numbers derives from women not appearing as admissions, but were referred (therefore, appeared in a referral register but not in an admission or maternity register). This is discussed in the methods and discussion sections.

Page 7, line 20: Who makes the determination that a facility is "ready" based on its ability to "treat eight of nine" emergency obstetric care signal functions? Why not all nine.

Authors’ response: We explain that one signal function (neonatal resuscitation) was excluded since the focus of the paper is on maternal complications and referral for those complications.

Page 8, Box 1: remove "&" throughout. Define MVA and D&C. Also, how did one determine whether or not healthcare worker availability ensured capability to treat a complication? For
example, just because gloves are available, doesn't mean that a midwife is competent to manually remove a placenta.

Authors’ response: Box text has been edited. We modified the text to reflect how the healthcare worker availability was determined. Unfortunately, observation of clinical skills was beyond the scope of the assessment.

Page 10, line 9: Was ethical approval also obtained from the University of North Carolina?

Authors’ response: ethical approval was not obtained from the University of North Carolina; their role was to support secondary data analysis of EmONC assessments in several countries. This paper is one of several.

Results

Page 10, Results: General comment: It would be interesting to know where the 977 facilities were geographically located. For example, how many were there at each level within each of the different regions of Ghana? This is important to know in order to improve the referral strategies. Were the lower level facilities distributed in both urban and rural areas? Why didn't you include data on the number of maternal deaths? Especially among the women referred.

Authors’ response: We have been concerned that additional analyses by region or urban/rural location would stray from the focus on readiness to treat complications and its relationship to referral. However, if a map showing regions and locations of the 977 facilities is desired, we can provide it but not by December 7. The lower level facilities were in both urban and rural areas and included all those that had provided an average of 5 births per month. We did add the absolute numbers of maternal deaths in Table 1.

Page 11, line 3-4: Other studies from Ghana have shown that referrals for hypertensive disorders of pregnancy outnumber referrals for antepartum hemorrhage. Again, it makes me wonder if some of the bleeding related complications are duplicated or how antepartum hemorrhage was defined (ie, could relatively minor bleeding, such as bloody show in labor be categorized as antepartum hemorrhage?)
Authors’ response: It is possible that the definition of APH was not strictly followed by data collectors, and/or primary sources such as referral logbooks misclassified the reason for referral. My suspicion is that “bleeding in pregnancy” was recorded as APH instead of incomplete or spontaneous abortion. We have acknowledged in the section on data limitations that this may be an issue; thank you for drawing out attention to this.

Page 11, line 10: Again it would be interesting to know how referral patterns varied by urban vs rural setting.

Authors’ response: This analysis was not done as mentioned above.

Page 12, Figure 3: Can you separate hospitals into district level and regional hospital levels, as this distinction is important to determine readiness and capability of treating complications as district hospitals often refer to regional (or higher) level hospitals.

Authors’ response: This information is in Table 2. However, I have revised Figure 3 since the graphic communicates the differentials in readiness between the teaching/regional hospitals and the district hospitals more easily/ more quickly than the table.

Page 12, line 21-22: Is this for all facilities, or only the hospitals?

Authors’ response: See track changes in text – the analysis refers to all facilities.

Page 13, line 15: Change "attended" to "conducted".

Authors’ response: change made.

Page 14, line 1: Define what is meant by "on-site communication".
Authors’ response: Text now includes how “on-site communication” is defined.

Page 14, line 4: Wouldn't this be consistent with the definition, not contrary to it?

Page 14, line 5-7: The fact that 22 of 248 district level facilities (some with significant numbers of deliveries) reported no complications or referrals, may underrepresent what is actually happening in district hospitals in terms of referrals (i.e. referrals are probably more than 9% as shown in Table 1).

Authors’ response: We agree and in the Discussion on limitations of the data we raise this as evidence that the number of complications and referrals are underrepresented or underestimated.

Discussion

Page 15, line 13: Again, some inclusion of geographic location would be pertinent, especially for the district level hospitals conducting the bulk of the obstetric patient care.

Page 16, line 1-2: Give a percent rather than "some".

Authors’ response: “Some” has been substituted and we now state that about 25% of cases of PPH and sepsis at health centers were resolved (not referred).

Page 16, line 10-11: Again this number may be artificially low as 9% of district hospitals likely had poor quality data.

Authors’ response: Noted in the text.

Page 17, line 3: …retained products of conception.

Authors’ response: added.
Page 17, line 20-21: Disaggregating the readiness data by district and regional hospital would be useful.

Authors’ response: Done.

Page 17, line 22-24: A regional or teaching hospital may be ready to treat serious complications sometimes, but these facilities are often overwhelmed by referrals, some unnecessary, thus diminishing the quality of care and driving up mortality. It would be useful to add in which category of facilities do the deaths occur.

Authors’ response: Deaths have been added and the rate of death is highest in the teaching and regional hospitals.

Page 18, line 22-23: Please remind readers which evidence presented may have under-represented the complications.

Authors’ response: We have reinforced in the text the impact of missing data at the 22 district hospitals.