Reviewer's report

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

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Reviewer: Medge Owen

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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.

Abstract:

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

Page 2, line 21: What is meant by "Improving conditions for referral"?

Background:

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

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.

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.
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?

Page 5, line 21-23: This needs to be updated. The institutional delivery rate is now even higher that 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.

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?

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

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

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?

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.

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.

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

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.

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?)

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

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.

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

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

Page 14, line 1: Define what is meant by "on-site communication".

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).
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".

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

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

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

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.

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

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