

CONFLUX MANUSCRIPT:

Title: Complications after Caesarean Section in Rwanda

ABSTRACT/SUMMARY:

Women in sub-Saharan Africa face a disproportionate risk of severe injury or death in childbirth when compared to women in Western countries. In 2016, Rwanda's maternal mortality rate (MMR) stood at 320 deaths per 100,000 deaths. In the five years before 2000, the MMR was 1071 per 100,000 deaths. Government investment in education and health infrastructure has allowed for this astonishing decreasing trend in maternal death.

Access to Cesarean section (CS) in Rwanda has greatly increased in the last decade. However, the rates and indications for CS in Rwanda has not been fully explored. Recent studies reveal an overuse of CS within district hospitals in Rwanda, which suggests improper selection of patients for surgery. High rates of CS places undue stress on the health system, exposes patients to unnecessary surgical risks, and predisposes women to subsequent delivery complications.

In this evolving and developing health system, it is vital to continually gather information about morbidity and mortality rates among new mothers. In an attempt to better understand the modifying effect of CS on immediate health outcomes, anesthesiologists at the Centre Hospitalier de Kigali (CHUK) designed a comprehensive project to measure CS complications.

Our study has three primary aims:

1. Investigate the relative rates of complications and maternal and child mortality after CS.
2. Understand the risk factors predisposing women to death: age, rural/urban living, distance from referral hospital.
3. Understand the indications for CS. Compare relative rates in urban vs. rural district hospitals (DH).

We analyzed a sample of 340 patient charts who were admitted in CHUK from June 2016 to June 2017 to identify the age, referral hospital, reason for CS and other demographic factors relating to morbidity and mortality of mothers and infants. We found peritonitis and sepsis to be the most common complications in mothers post-CS. After conducting a Fisher's exact test, we found no significant relationship between geographic distance from the hospital and mortality and between type of delivery and mortality. Inclusion criteria for our study excluded those who did not survive the travel from the district hospital and CHUK, which limited our results. Future research groups should collect data from a larger population set and explore the feasibility of data collection directly from the district hospitals. We obtained comprehensive information on CS rates from the main referral hospitals, which can be used to develop protocols to limit unnecessary CS, as well as to address the surprisingly high rates of peritonitis and sepsis.

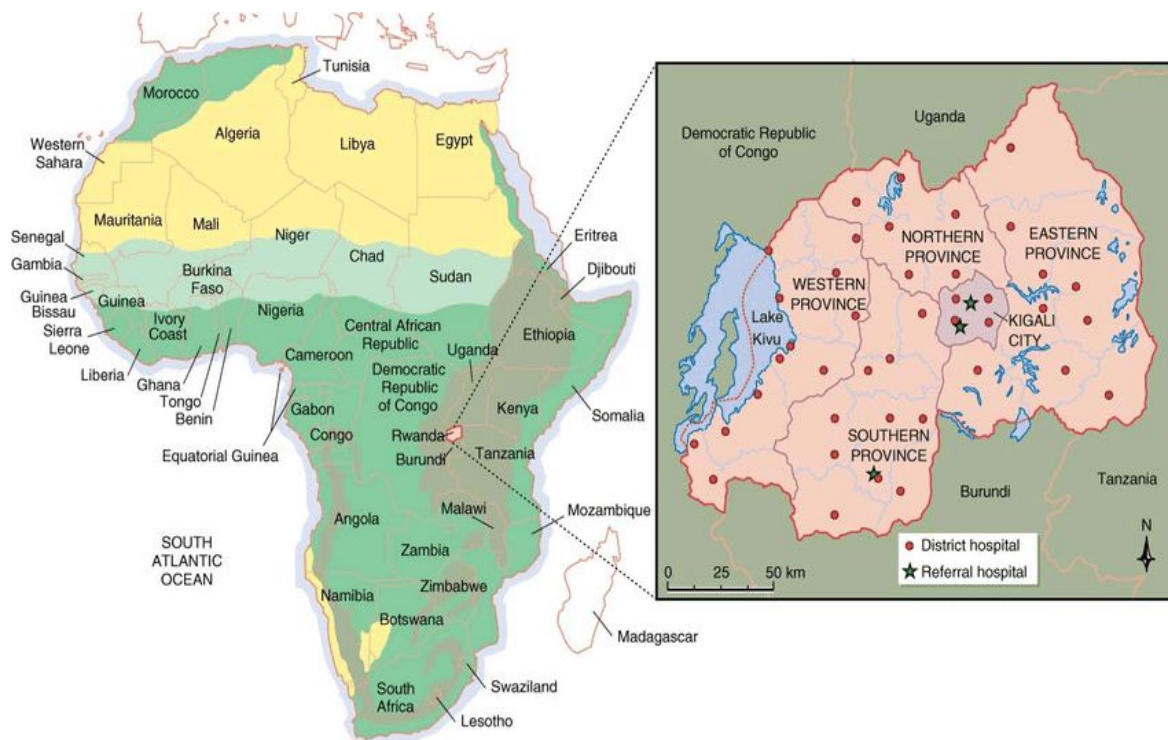
BACKGROUND / RATIONALE

There is a dearth of epidemiologic data available on the rates and indications for Caesarean section in sub-Saharan Africa. The World Health Organization (WHO) recommends CS rates of 10-15% as optimal. In Rwanda, the CS rate has increased as the health system has expanded, and was estimated to be as high as 45% in 2011 [1]. An executive summary on the topic concludes, "Every effort should be made to provide caesarean section to women in need, rather

than striving to achieve a specific rate.”

Prior studies demonstrate that CS has little to no benefit for patients in which the procedure is not medically justified [2]. When not required, CS can contribute to increased mortality and morbidity that can continue for years after the procedure and affect the woman’s future pregnancies. This risk is compounded in women with no access to continual and comprehensive obstetric care, which includes much of Rwanda’s rural population [3, 4].

The majority of CS are performed in the country’s 48 district hospitals. Women with severe obstetric complications are transferred to one of the four national tertiary-level hospitals for further management.



Source: British Journal of Surgery, 2012. (Used with permission.)

Global health initiatives in sub-saharan Africa emphasize improving access to surgery and emergency care as a means to reduce obstetric complications [5]. However, no protocols exist in Rwanda to control or monitor the rates of CS use in the country’s district hospitals [6].

In the past decade, Rwanda’s maternal mortality ratio (MMR) has decreased significantly to 320 deaths per 100,000 live births [7]. An effort to understand the complications and risks associated with CS is important to further reduce the MMR in low-income countries.

METHODOLOGY

This retrospective study was a facility-based chart review of 340 cases of severe maternal morbidity and mortality that took place in the years 2016-2017 at Centre Hospitalier de Kigali (CHUK), Rwanda. CHUK is the largest public hospital in Rwanda, located in the capital city Kigali. It serves as a tertiary care referral center for providing advanced and specialized care.

Women admitted to the CHUK obstetrics service with severe morbidity following CS or vaginal delivery were included. Patients were identified through review of the surgical ward admissions log and through provider identification of eligible patients. Demographic characteristics and factors related to morbidity (near-miss) and mortality of mothers and infants were assessed using paper-based standardized health records stored at CHUK.

OUTCOMES

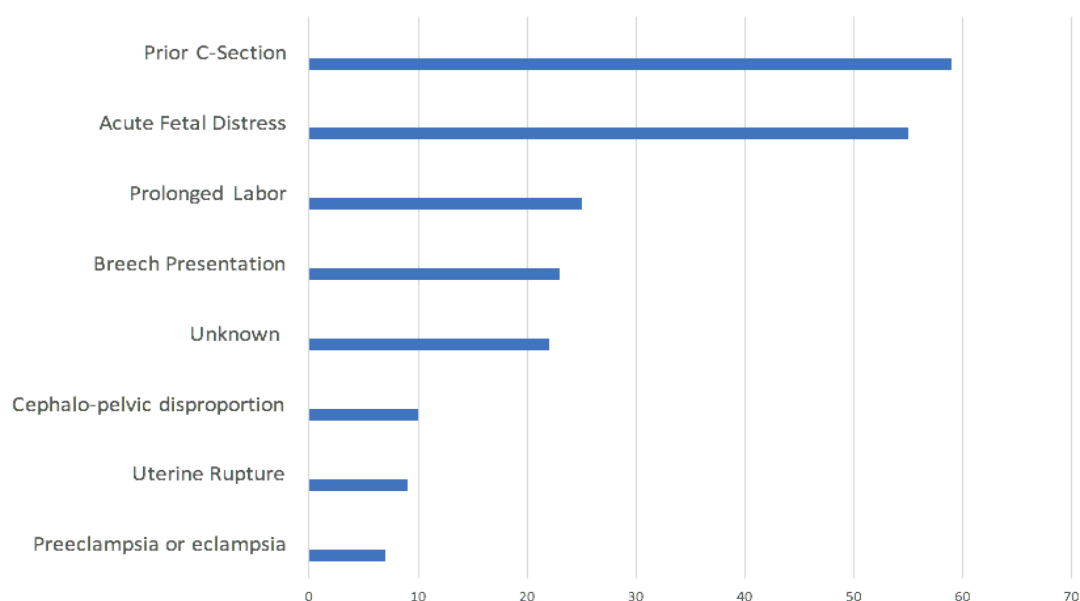
After collecting 340 charts of severe maternal morbidity and mortality cases in the years 2016-2017, the cases were categorized as either cesarean section deliveries (n=271) or as vaginal deliveries (n=69). Analysis of each group was done separately to identify delivery-specific risks.

Table 1. Demographic Characteristics of Study Population

Characteristic	Vaginal Delivery (n=69)	Cesarean Section (n=271)
Mean Age (years)	28.85	29.11
Duration of hospital stay (days)	6.91	16.5
Delivery at home	9 (13.04%)	--
Referred from rural district	49 (71.01%)	194 (71.59%)
Referred from Kigali city	20 (28.99%)	77 (28.41%)
Insured	61	243

To further analyze the CS deliveries, the study identified the primary indicators for cesarean section as noted in the patient's chart.

Figure 1. Primary indicators for CS



To fully analyze the deaths and near misses of mothers and infants, the primary causes of mortality and morbidity were recorded based on the presence of a death certificate and notes in the patient's chart.

Table 2. Primary causes of severe maternal outcome and mortality post CS

Condition	Prevalence n=271 (%)	Maternal deaths n=49 (%)	Infant deaths n=41 (%)
Peritonitis	162 (58.7)	25 (51.0)	28 (68.2)
Sepsis	18 (6.6)	9 (18.4)	1 (2.4)
Septic Shock	12 (4.4)	14 (28.6)	2 (4.9)
Hemorrhage	76 (28.0)	17 (34.7)	11 (26.8)
Hemorrhagic shock	26 (9.6)	17 (34.7)	11 (26.8)
Cardiac Arrest	8 (3.0)	8 (16.3)	1 (2.4)
Eclampsia	12 (4.4)	7 (14.3)	1 (2.4)
DIC	9 (3.3)	5 (10.2)	1 (2.4)

The researchers identified three risk factors to analyze for near-miss or fatal outcomes: maternal age, the location of delivery and the type of delivery. The age and type of delivery was taken from the patient's chart. The location of delivery was assumed to be the hospital the patient was transferred from, as noted in the hospital admission sheet. A tally of each outcome categorized

by the risk factors is listed in Table 3.

Table 3. Factors related to near-miss or death outcome

Characteristics	Near-miss n=278 (%)	Maternal death n=62 (%)
Age	29.34	27.92
Referred		
Kigali DH	81 (29.14)	16 (25.81)
Rural DH	197 (70.86)	46 (74.19)
Type of Delivery		
Cesarean Section	222 (79.9)	49 (79.0)
Vaginal Delivery	56 (20.1)	13 (21.0)

To compare the mortality rates for the location of referral and type of delivery, a fisher's exact test was performed using R studio. The odds ratio, a 95% confidence interval and the p-value are listed below for each test.

Table 4. Fisher's test for mortality by delivery characteristics

Risk factor	Fisher's Exact Test Odds ratio (95% CI)	P-value
Mortality of rural vs. city DH referral	1.26 (0.658, 2.53)	0.541
Mortality of Cesarean section vs. Vaginal Delivery	0.813 (0.396, 1.763)	0.586

Discussion

This preliminary study aimed to report the major causes of maternal mortality and morbidity in Rwanda's largest referral hospital. Prior studies identify the most common post-delivery complication as postpartum hemorrhage (PPH). In contrast, our study found that the most common post-CS complication for the CHUK population was peritonitis (58.7%). This finding is consistent with recent studies of the entire CHUK obstetric population [8, 9].

Peritonitis is associated with 51 percent of maternal deaths within 2016-2017. This concerning level of infection-related deaths further underscores the need to implement rigorous aseptic procedures in the wards where surgeries are taking place.

The most likely complication to progress to maternal death is PPH, which resulted in 17 of 76 deaths. The number of total PPH cases in our population was lower than expected. This could be explained by the exclusion from our study of patients who died of complications before they could be transferred to CHUK. Patients with rapidly progressive complications like PPH are more likely to be excluded from the study population. Many of these deaths occur due to missed or delayed diagnosis, lack of uterotonic agents in the district hospitals or a lack of trained personnel to manage PPH [10]. Because women who had non-elective Cesarean deliveries are at higher risk of PPH, such cases should be closely monitored for potential PPH and prior preparation can be made to quickly employ the necessary resources in case of emergency. [11,12]

When comparing the mortality rate among CS and vaginal delivery groups, we found no statistically significant difference. The p-value is greater than 0.05 ($p=0.541$), so the null hypothesis was not rejected. We also concluded there is no statistically significant relationship between mortality and the place of referral. Similarly, the p-value for the Fisher's exact test for type of delivery and mortality was greater than 0.05 ($0.586 > 0.05$) so there is not enough evidence to suggest a statistically significant relationship between type of delivery and mortality.

The statistically insignificant relation between district hospital location and mortality may be similarly affected by the inclusion criteria. The statistically insignificant relationship between vaginal delivery and Cesarean delivery could also be due to the inclusion criteria, as the only vaginal deliveries counted were those that ended in a complication. However, the sample size was too small to continue to do analysis.

Conclusions

The study found an 18% mortality rate in women who experienced post-CS complications. Peritonitis was the leading cause of post-CS morbidity in Rwanda. Hemorrhage was the most common cause of fatal complication. The study did not find a significant difference in mortality between those referred from rural hospitals and urban hospitals. Our results highlight the importance of creating protocols to a) reduce the number of CS performed, particularly in rural areas;

b) work to create protocols to reduce incidence of hemorrhage and sepsis.

References

1. Bucagu, M., Kagubare, J. M., Basinga, P., Ngabo, F., Timmons, B. K., & Lee, A. C. (2012). Impact of health systems strengthening on coverage of maternal health services in Rwanda, 2000–2010: a systematic review. *Reproductive health matters*, 20(39), 50-61.
2. Souza, J. P., Gülmezoglu, A. M., Lumbiganon, P., Laopaiboon, M., Carroli, G., Fawole, B., & Ruyan, P. (2010). Caesarean section without medical indications is associated with an increased risk of adverse short-term maternal outcomes: the 2004-2008 WHO Global Survey on Maternal and Perinatal Health. *BMC medicine*, 8(1), 71.
3. Clark, S. L., Belfort, M. A., Dildy, G. A., Herbst, M. A., Meyers, J. A., & Hankins, G. D. (2008). Maternal death in the 21st century: causes, prevention, and relationship to cesarean delivery. *American Journal of Obstetrics & Gynecology*, 199(1), 36-e1.
4. Deneux-Tharoux C, Carmona E, Bouvier-Colle MH, and Bréart G. Postpartum Maternal Mortality and Cesarean Delivery. *Am J Obstet Gynecol* 2006; Sep;108(3 Pt 1):541-8.
5. Beck, S., Wojdyla, D., Say, L., Betran, A. P., Merialdi, M., Requejo, J. H., ... & Van Look, P. F.

- (2010). The worldwide incidence of preterm birth: a systematic review of maternal mortality and morbidity. *Bulletin of the World Health Organization*, 88, 31-38.
6. Notrica, M. R., Evans, F. M., Knowlton, L. M., & McQueen, K. K. (2011). Rwandan surgical and anesthesia infrastructure: a survey of district hospitals. *World journal of surgery*, 35(8), 1770-1780.
 7. Manzi, A., Munyaneza, F., Mujawase, F., Banamwana, L., Sayinzoga, F., Thomson, D. R., ... & Hedt-Gauthier, B. L. (2014). Assessing predictors of delayed antenatal care visits in Rwanda: a secondary analysis of Rwanda demographic and health survey 2010. *BMC pregnancy and childbirth*, 14(1), 290.
 8. Rulisa, S., Umuziranenge, I., Small, M., & van Roosmalen, J. (2015). Maternal near miss and mortality in a tertiary care hospital in Rwanda. *BMC pregnancy and childbirth*, 15(1), 203.
 9. Halfon, J. K. (2016). *Post-Cesarean Section Peritonitis at a Referral Hospital in Rwanda: Factors Associated with Maternal Morbidity and Mortality* (Doctoral dissertation, Duke University).
 10. Petroze, R. T., Nzayisenga, A., Rusanganwa, V., Ntakiyiruta, G., & Calland, J. F. (2012). Comprehensive national analysis of emergency and essential surgical capacity in Rwanda. *BJS*, 99(3), 436-443.
 11. Stanton, C. K., & Holtz, S. A. (2006). Levels and trends in cesarean birth in the developing world. *Studies in family planning*, 37(1), 41-48.
 12. Johnson, K., Posner, S. F., Biermann, J., Cordero, J. F., Atrash, H. K., Parker, C. S., ... & Curtis, M. G. (2006). Recommendations to Improve Preconception Health and Health Care—United States: Report of the CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception Care. *Morbidity and Mortality Weekly Report: Recommendations and Reports*, 55(6), 1-CE.