# Characteristics of Intestinal Volvulus and Risk of Mortality in Malawi

**Laura N. Purcell[1] · Rachel Reiss[1] · Charles Mabedi[2] · Jared Gallaher[1] · Rebecca Maine[1] · Anthony Charles[1,2]**

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## Abstract

*Background* Intestinal volvulus is a common cause of mechanical intestinal obstruction (MIO) in Africa. Sigmoid volvulus has been well characterized in both high-income and low-income countries, but there is also a predilection for small bowel volvulus in sub-Saharan Africa.

*Methods* An analysis was performed of the Kamuzu Central Hospital Acute Care Surgery Registry from 2013 to 2019 on patients presenting with intestinal volvulus. Bivariate analysis was performed for covariates based on the intestinal volvulus type. Multivariate Poisson regression models estimated the relative risk of volvulus and mortality.

*Results* A total of 4352 patients were captured in the registry. Overall, 1037 patients (23.8%) were diagnosed with MIO. Intestinal volvulus accounted for 499 (48.1%) of patients with MIO. Sigmoid volvulus, midgut volvulus, ileosigmoid knotting, and cecal volvulus accounted for 57.7% ($n$ = 288), 19.8% ($n$ = 99), 20.8% ($n$ = 104), and 1.6% ($n$ = 8), respectively. Mean age was 46.8 years (SD 17.2) with a male preponderance ($n$ = 429, 86.0%) and 14.8% ($n$ = 74) mortality. Overall, the most common operations performed were large bowel ($n$ = 326, 74.4%) and small bowel ($n$ = 76, 16.7%) resections with 18.0% ($n$ = 90) ostomy formation. Upon regression modeling, the relative risk for volvulus was 2.7 times higher in men than women after controlling for season and age. There was no statistically significant difference in the relative risk of mortality based on the type of volvulus.

*Conclusion* Volvulus is a significant cause of primary bowel obstruction in sub-Saharan Africa. Type of intestinal volvulus is not associated increased risk of mortality. Reasons for increases in the incidence of small bowel volvulus are still largely undetermined.

## Introduction

Mechanical intestinal obstruction (MIO) is a common disorder necessitating emergency general surgical evaluation and treatment worldwide. It accounts for approximately 20% of all emergent surgical admission, but the etiopathogenesis of MIO demonstrates considerable variation depending on age and geographic location [1]. While intra-abdominal adhesions and incisional hernias predominate the etiology of MIO in high-income countries (HIC), volvulus, abdominal wall hernias, and adhesions are responsible for the majority of MIO in low- and middle-income countries (LMIC) [1–5].

Volvulus is a mechanical intestinal obstruction resulting from abnormal twisting of a loop of bowel around the axis of its mesentery. Volvulus is a common cause of MIO in the "volvulus belt" stretching across Africa, the Middle East, and Russia [6]. In sub-Saharan Africa (SSA),

Anthony Charles
anthchar@med.unc.edu

[1] Department of Surgery, University of North Carolina School of Medicine, 4008 Burnett Womack Building, Chapel Hill, NC 7228, USA

[2] Department of Surgery, Kamuzu Central Hospital, Lilongwe, Malawi

volvulus accounts for 9–56% of all MIO [7–10]. Compared to counterparts in high-income countries, affected patients in SSA are younger and overwhelmingly male [6, 11]. While the annual incidence of primary small bowel volvulus in industrialized nations is 1.7–5.7 per 100,000 persons, the annual incidence in the Middle East, Asia, and Africa is 24–60 per 100,000 persons. [12–14]. Another variation of intestinal volvulus involving the small bowel is ileosigmoid knotting, which appears to be relatively more common in SSA [15]. Ileosigmoid knotting occurs when the ileum wraps around the sigmoid colon and its mesentery or vice versa. Similarly, large bowel volvulus is common in SSA, particularly sigmoid and cecal volvulus. Sigmoid volvulus (SV) accounts for approximately 70–80% of all large bowel volvulus, and the sigmoid colon wraps around itself and its mesentery. In cecal volvulus, a mobile cecum and ascending colon rotate along its long axis. [7, 16–19].

The increased incidence of disease in this setting is posited to be secondary to anatomical variations, dietary patterns, bowel motility, and the prevalence of chronic constipation [5].

Given the wide geographical variation in the pattern of MIO in sub-Saharan Africa, we sought to describe the epidemiological and clinical characteristics in patients presenting with MIO due to volvulus in Malawi and to determine factors associated with in-hospital mortality.

## Methods

A retrospective analysis of the prospectively collected Kamuzu Central Hospital (KCH) Acute Care Surgery Database from September 1, 2013, to November 30, 2019, was performed. All patients presenting to KCH with acute care general surgery conditions are included in the database. All adult patients (>12 years) who presented with a postoperative diagnosis of MIO secondary intestinal volvulus were included in the study. Classification of intestinal volvulus was diagnosed intra-operatively and obtained from the surgeon's operative reports. Patients with prior abdominal surgeries were not excluded.

KCH is a 900-bed tertiary hospital located in Lilongwe, Malawi. It is the tertiary hospital for eight district hospitals in central Malawi, whose catchment is six million people. Four general surgeon consultants, 11 general surgery residents, and six surgical clinical officers in four operating rooms provide surgical care at KCH. Anesthesia care is provided by clinical officer anesthetists. KCH has two surgical wards for men and women, a five-bed high dependency unit, and a five-bed intensive care unit.

The surgical procedure performed for patients presenting with volvulus depended on the patient's clinical condition, preoperative findings, bowel viability, and the surgeon's experience. Procedures included resection and primary anastomosis, resection with end ileostomy or colostomy, and in sigmoid volvulus, a meso-sigmoidopexy.

The overall study cohort was examined with univariate analysis to determine data distribution and missing data. The central tendency in the univariate and bivariate analysis is reported as means (standard deviation [SD]) and medians (interquartile range [IQR]) for covariates, which were normally and non-normally distributed, respectively. Bivariate analysis was performed by volvulus type. To compare the distribution of patient characteristics and outcomes across volvulus type, $\chi^2$ for categorical variables, analysis of variance for normally distributed continuous variables, and Kruskal–Wallis for non-normally distributed continuous covariates were utilized.

To determine the risk of volvulus by sex, we performed a multivariate Poisson regression. A priori, the model included age and season of presentation and evaluated all other variables requiring a $p < 0.05$ for inclusion in the final model. Therefore, the fully adjusted model included age and season of presentation. All variables were significant in the model, and therefore none were removed in backward elimination to reduce bias.

To determine the risk of mortality by volvulus type, we performed a multivariate Poisson regression, including sex, age, and days to presentation at KCH in the model a priori. Cecal volvulus was excluded from the regression due to the paucity of cecal volvulus in our cohort. The type of operation was included in the fully adjusted model because it was significant on bivariate analysis, $p < 0.05$. No variables were removed as no covariates meet the criteria of removal {confidence interval narrowing and less than 10% change in relative risk coefficients).

This analysis was performed using StataCorp v14.2, College Station, Texas. Confidence intervals are reported at 95%, and alpha was set at 0.05 for this study. Malawi's National Health Science Research Committee and the University of North Carolina Institutional Review Boards approved this study.

## Results

The KCH Acute Care Surgery Database captured 4352 patients during the study period, and 1037 patients (23.8%) were diagnosed with MIO. Overall, 499 (11.5%) patients presented with intestinal volvulus accounting for 48.1% of the patients presenting with MIO, Fig. 1. The intestinal volvulus cohort was primarily male ($n$ = 429, 86.0%), transferred from an outside hospital ($n$ = 444, 89.6%), and with an admission diagnoses of both bowel obstruction ($n$ = 287, 57.5%) and intestinal volvulus ($n$ = 241, 48.3%).

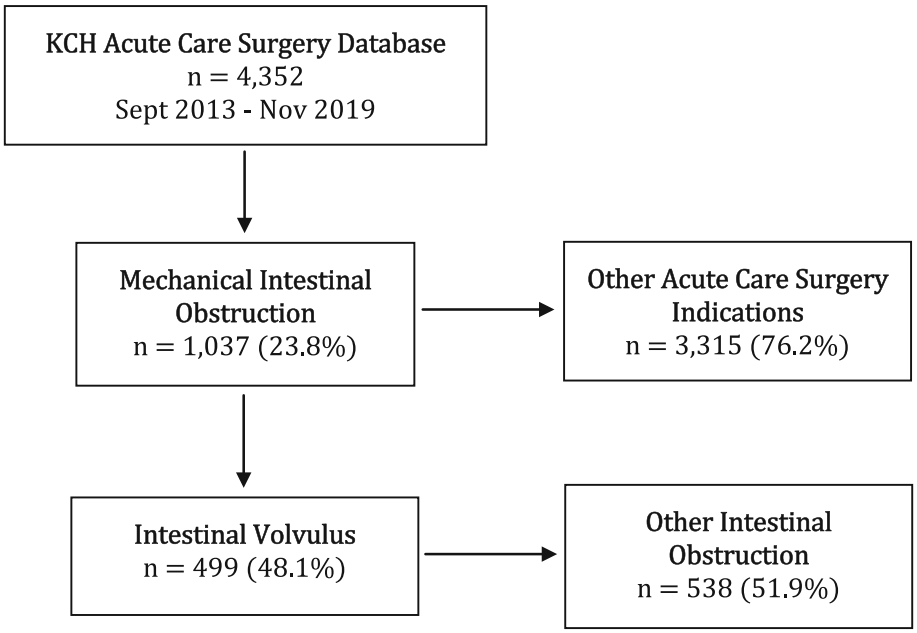


**Fig. 1** Mechanical intestinal obstruction and intestinal volvulus flow diagram

Overall, mortality was 14.8% ($n = 74$) in the intestinal volvulus cohort (Table 1).

Among the type of volvuli, the majority were sigmoid volvuli ($n = 288$, 57.7%), followed by ileosigmoid knotting ($n = 99$, 19.8%), midgut ($n = 104$, 20.8%), and cecal volvuli ($n = 8$, 1.6%). Patients with sigmoid (50.7 years, SD 17.0) and ileosigmoid knotting (45.4 years, SD 15.5) volvuli were older compared to those with midgut (38.0 years, SD 16.1) and cecal (34.5 years, SD 14.1) volvuli, $p < 0.001$. Patients with ileosigmoid knotting (1 day, IQR 1–2) volvuli presented earlier than those with midgut (3 days, IQR 1–5) and sigmoid (3 days, IQR 1–5) volvuli, $p < 0.001$. Large and small bowel resections were the primary surgical procedures performed overall, with ostomies were more often performed in patients with ileosigmoid knotting ($n = 23$, 24.0%) and midgut volvulus ($n = 18$, 20.2%). Patients with midgut volvulus had the highest mortality ($n = 18$, 17.3%), followed by sigmoid volvulus ($n = 44$, 15.3%) and ileosigmoid knotting ($n = 11$, 11.1%), ($p = 0.6$). While patients with sigmoid volvulus had the highest number of unplanned returns to the operating room ($n = 12$, 4.6%), and patients with midgut volvulus had the highest number of postoperative wound infections ($n = 5$, 5.6%), neither were statistically significant, Table 1.

The Poisson regression model demonstrated male sex was associated with an increase in the relative risk of presenting with an intestinal volvulus of any type (RR 2.74, 95% CI 2.15–3.50, $p < 0.001$). Furthermore, older age (RR 1.02, 95% CI 1.01–1.02, $p < 0.001$) increased the relative risk of volvulus. Finally, the relative risk of volvulus was highest during the rainy (RR 1.61, 95% CI 1.25–2.08, $p < 0.001$) and lush and green seasons (RR 1.69, 95% CI 1.33–2.14, $p < 0.001$), Table 2.

There was no statistical difference in the risk of mortality for midgut volvulus (RR 2.65, 95% CI 0.92–7.59, $p = 0.07$) or ileosigmoid knotting (RR 0.93, 95% CI 0.46–1.89, $p = 0.8$) when compared to sigmoid volvulus after controlling for age, sex, days to presentation, and operation performed, Table 3.

## Discussion

In this study, we demonstrated volvuli account for a significant proportion of the etiology for mechanical intestinal obstruction and carries a mortality of 14.8%. Furthermore, men are 2.74 times more likely than women to present with volvulus, after controlling for season and age. The risk of mortality did not differ significantly between types of intestinal volvulus.

Our observed mortality following volvuli is comparable to other studies in LMIC's. In a Peruvian study looking at sigmoid volvulus, they showed a mortality of 19.4% [20]. Similarly, in a study from Tanzania, the overall mortality following sigmoid volvulus was 17.1% [21]. Patients who presented with ileosigmoid knotting had a mortality of 11.1% in our study, similar to a Kenyan study by Ooko et al. [17] that revealed a mortality of 11.5%. However, other studies in the region revealed higher mortality, such as Kotisso et al. [22] from Ethiopia, that showed a 20% mortality for ileosigmoid knotting. Though small bowel

**Table 1** Demographics and outcomes of patients with intestinal volvulus

| | Overall $n = 499$ | Cecal volvulus $n = 8$ (1.6%) | Midgut volvulus $n = 104$ (20.8%) | Sigmoid volvulus $n = 288$ (57.7%) | Ileosigmoid knotting $n = 99$ (19.8%) | $p$ value |
|---|---|---|---|---|---|---|
| Age (years): mean (SD) | 46.8 (17.2) | 34.5 (14.1) | 38.0 (16.1) | 50.7 (17.0) | 45.4 (15.5) | <0.001 |
| Male: *n* (%) | 429 (86.0) | 6 (75.0) | 83 (79.8) | 253 (87.9) | 87 (87.9) | 0.2 |
| Days to presentation[a]: median (IQR) | 3 (1–5) | 2.5 (2–4) | 3 (1–5) | 3 (1–5) | 1 (1–2) | <0.001 |
| Transferred: *n* (%) | 444 (89.6) | 8 (100) | 95 (91.4) | 251 (87.5) | 92 (92.9) | 0.3 |
| Season[b]: *n* (%) | | | | | | 0.3 |
| Rainy | 114 (22.9) | 0 (0.0) | 22 (21.2) | 64 (22.3) | 28 (28.3) | |
| Lush/green | 163 (32.7) | 4 (50.0) | 30 (28.9) | 97 (33.8) | 32 (32.3) | |
| Cold/dry | 95 (19.1) | 0 (0.0) | 20 (19.2) | 55 (19.2) | 20 (20.2) | |
| Hot/dry | 126 (25.3) | 4 (50.0) | 32 (30.8) | 71 (24.7) | 19 (19.2) | |
| Admission diagnosis: *n* (%) | | | | | | |
| Bowel obstruction | 287 (57.5) | 2 (25.0) | 61 (58.7) | 168 (58.3) | 55 (56.6) | 0.3 |
| Peritonitis | 33 (6.7) | 1 (12.5) | 16 (15.4) | 9 (3.1) | 7 (7.1) | <0.001 |
| Volvulus | 241 (48.3) | 5 (62.5) | 40 (38.5) | 144 (50.0) | 52 (52.5) | 0.1 |
| Operation: *n* (%) | | | | | | <0.001 |
| Large bowel resection | 326 (74.4) | 2 (28.6) | 16 (18.8) | 326 (93.3) | 72 (77.4) | |
| Small bowel resection | 76 (16.7) | 5 (71.4) | 51 (60.0) | 0 (0.0) | 14 (18.3) | |
| Lysis of adhesions | 6 (1.4) | 0 (0.0) | 2 (2.4) | 2 (0.8) | 2 (2.2) | |
| Sigmoidopexy | 16 (3.7) | 0 (0.0) | 0 (0.0) | 14 (5.5) | 2 (2.2) | |
| Decompression | 17 (3.9) | 0 (0.0) | 0 (0.0) | 1 (0.4) | 0 (0.0) | |
| Ostomy: *n* (%) | 90 (18.0) | 1 (12.5) | 21 (20.2) | 42 (14.6) | 26 (26.3) | 0.06 |
| Length of stay: median (IQR) | 7 (5–10) | 12.5 (5–24.5) | 6 (4–11) | 7 (5–10) | 8 (6–10) | 0.06 |
| Died: *n* (%) | 74 (14.8) | 1 (12.5) | 18 (17.3) | 44 (15.3) | 11 (11.1) | 0.6 |
| Disposition: *n* (%) | | | | | | 0.9 |
| Death | 74 (14.8) | 1 (12.5) | 18 (17.3) | 44 (15.3) | 11 (11.1) | |
| Discharge | 410 (82.2) | 7 (87.5) | 83 (79.8) | 233 (80.9) | 87 (87.9) | |
| Abscond | 12 (2.4) | 0 (0.0) | 2 (1.9) | 9 (3.1) | 1 (1.0) | |
| Transfer | 3 (0.6) | 0 (0.0) | 1 (1.0) | 2 (0.7) | 0 (0.0) | |
| Complications: *n* (%) | | | | | | |
| Wound Infection | 15 (3.0) | 1 (12.5) | 6 (5.7) | 6 (2.1) | 2 (2.0) | 0.1 |
| Unplanned return to operating room | 16 (3.2) | 0 (0.0) | 2 (1.9) | 12 (4.2) | 2 (2.0) | 0.5 |
| Dehiscence | 7 (1.4) | 1 (12.5) | 0 (0.0) | 6 (2.1) | 0 (0.0) | 0.01 |

[a]Days to presentation include time from the patient-reported onset of symptoms until arrival at Kamuzu Central Hospital

[b]Seasons are as follows: rainy from December to February which correlate with mango season, lush/green from March to May which corresponds with harvest, cold/dry from June to August, and hot/dry lasting from September to November

volvulus is thought to be rare, it accounted for 20% of all the volvuli seen in this study.

Men and women have an equal predilection for sigmoid volvulus in Europe and the USA, and most are over 60 years of age with a history of institutional care [23]. The reasons for the male preponderance of volvulus in parts of Africa, Asia, and Latin America are yet to be delineated. For sigmoid volvulus, some proposed explanations of this sex difference are based on the broader, more relaxed female pelvis in women, allowing for spontaneous reduction of the volvulus [24]. Other studies have found that men have longer and narrower sigmoid mesenteric pedicles than females, resulting in a male predisposition to axial rotation of the sigmoid colon [25]. Finally, sex differences in seeking care for surgical conditions or lower rates of

**Table 2** Poisson multivariate regression for relative risk of intestinal volvulus

| | Risk ratio | 95% confidence interval | *p* value |
|---|---|---|---|
| Male sex | 2.74 | 2.15–3.50 | <0.001 |
| Age | 1.02 | 1.01–1.02 | <0.001 |
| Season[a] | | | |
| Cold/dry | Ref | – | – |
| Rainy | 1.61 | 1.25–2.08 | <0.001 |
| Lush/green | 1.69 | 1.33–2.14 | <0.001 |
| Hot/dry | 1.27 | 0.99–1.63 | 0.06 |

[a]Seasons are as follows: rainy from December to February which correlated with mango season, lush/green from March to May which corresponds with harvest, cold/dry from June to August, and hot/dry lasting from September to November

**Table 3** Poisson multivariate regression for relative risk of mortality

| | Risk ratio | 95% confidence interval | *p* value |
|---|---|---|---|
| Male sex | 0.72 | 0.37–1.41 | 0.3 |
| Age | 1.02 | 1.01–1.04 | 0.002 |
| Type of volvulus | | | |
| Sigmoid volvulus | Ref | – | – |
| Ileosigmoid knotting | 0.93 | 0.46–1.89 | 0.8 |
| Midgut volvulus | 2.65 | 0.92–7.59 | 0.07 |
| Days to presentation | 0.99 | 0.98–1.00 | 0.2 |
| Operation performed | | | |
| Large bowel resection | Ref | – | – |
| Small bowel resection | 0.44 | 0.15–1.26 | 0.1 |
| Sigmoidopexy | 0.49 | 0.07–3.44 | 0.5 |
| Decompression | 0.21 | 0.02–2.62 | 0.2 |

surgical intervention for female patients may contribute to this observed difference [26].

Although the etiology of sigmoid volvulus, cecal volvulus, ileosigmoid knotting, or midgut volvulus is not well described, three common potentiating factors emerge. First, there is usually an associated long mesentery in the volvulized segment, resulting in a freely mobile bowel segment. Second, there is usually a dietary practice of consuming a coarse, high-fiber vegetable diet in the presence of an empty bowel. This is supported by increasing an incidence during harvest season when individuals in farming societies tend to consume one large meal daily [27–29]. Primary midgut volvulus is torsion of all or a large segment of the small bowel and proximal large bowel mesentery. In the absence of congenital malrotation, congenital bands, or postoperative adhesions may be the primary etiology for midgut volvulus [30]. The etiologic mechanisms that favor the development of primary midgut volvulus have not been fully defined. However, in addition to the factors listed above, there is some evidence to suggest that parasitic infections and diabetic autonomous neuropathy play a role [31, 32].

We observed a seasonal variation to the incidence of volvulus in Malawi with a disproportionally increased incidence after the rainy season when the terrain is lush and green. These increases correlate with the harvest of high-fiber crops such as fruits and vegetables. The importance of a high-residue diet in the development of volvulus has been highlighted, particularly in sub-Saharan Africa [33]. This seasonal variation, which is similar for both small and large bowel volvulus in this study, has been corroborated in other regions of Africa [34].

The disproportionate burden and high mortality of volvulus in SSA are, in part, attributable to poor access to surgical care and low surgical capacity. Delays in presentation, diagnosis, and intervention are common in low-resource settings. There are prehospital delays such as transportation and inadequate roads that make the initial presentation to a health care facility difficult. There are in-hospital delays due to the lack of surgical capacity by the health care facility as they often lack trained surgical personnel, imaging capabilities, adequate blood supply, or infrastructural necessities such as reliable power [4, 21, 35]. As seen in our study, 90% of our patients were transferred from the district hospitals to our tertiary care center. Although our study does not demonstrate a connection between mortality and delayed transfer in this population, it is well described that delays in operation for patients with operative MIO increase the illness severity in these patients. They are more likely to be dehydrated with electrolyte imbalance, metabolic derangement, and loss of bowel viability and gangrene [4, 5, 36, 37]. Indeed, patients with volvulus in SSA are 1.5–4 times more likely to die than their counterparts in high-income settings (6–16% vs. 4% case fatality rates) [5, 7, 9, 21, 37–41]. With minimal critical care resources in SSA, preventing gangrenous bowel and accompanying sepsis is the most crucial step in preventing mortality.

This study has several limitations common to any study with a retrospective methodology. There is a selection bias as we only see patients that were referred to our center. Consequently, we likely underreport the associated mortality with this condition as some patients may not survive the transfer to our center. The details of the operative decision-making are unknown but deserve further study. Furthermore, the gross surgical finding and the bowel viability of the volvulized intestinal segment is unknown, as is the potential cause of the volvulus. The exact cause of in-hospital death following volvulus is presumed to be related to the MIO and its sequelae. Finally, as the data are collected by non-healthcare trained data clerks and poor

medical record collection in our institution like many hospitals in LMIC, there can be errors in data collection. There may have been misclassification in procedures performed. Some of the sigmoid volvulus operations were misclassified as small bowel resections, likely confused with sigmoidectomy. Therefore, for analysis, these misclassified data points were corrected to reflect the appropriate bowel resected.

## Conclusion

Volvulus of the small and large bowel is a common cause of MIO in sub-Saharan Africa, with high mortality relative to high-income countries. In our population, older males were more likely to present with this condition, and there appear to be seasonal variation on the incidence, likely related to dietary habits. The location and type of volvulus do not confer an increased risk of mortality. Further studies are needed to identify why intestinal volvulus has an increased incidence in sub-Saharan Africa.

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