District General Hospital Surgical Capacity and Mortality Trends in Patients with Acute Abdomen in Malawi

Laura N. Purcell[1] · Brittany Robinson[2] · Vanessa Msosa[3] · Jared Gallaher[1] · Anthony Charles[1,3]

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Abstract

Background The burden of emergency general surgery conditions is high in sub-Saharan Africa, and poor access to surgical care leads to poor patient outcomes. We examined the trends in mortality in patients presenting with an acute abdomen to a referral hospital.

Methods A retrospective analysis of the prospectively collected Kamuzu Central Hospital Acute Care Surgery database was performed (January 2014 to July 2019). Bivariate analysis was conducted by year of admission. A multivariate Poisson regression was performed to identify predictors of mortality.

Results During the study, 2509 patients with acute abdomen presented. The majority of patients presenting were transferred from outside hospitals (n = 2097, 83.9%). Mortality was highest in patients with preoperative diagnosis of peritonitis (n = 119, 22.2%), bowel obstruction (n = 214, 18.7%), and volvuli (n = 51, 18.6%). There was no difference in mortality by year, p = 0.1. On multivariate Poisson regression, there was an increased relative risk of mortality with being transferred (RR 1.31, 95% CI 1.12–1.55, p = 0.002), as well as undergoing an operation within 1–2 days (RR 1.48, 95% CI 1.16–1.87, $p < 0.001$) and >2 days (RR 1.46, 95% CI 1.17–1.82, p = 0.001) after presentation.

Conclusion The majority of patients in our study who presented with an acute abdomen were transferred from district hospitals, which resulted in high mortality due to delays in surgical care. Therefore, the WHO's recommendation that the majority of district hospitals perform the Bellwether procedures does not occur in district hospitals in central Malawi. District hospitals require significant resource investment to reduce transfers needs and patient mortality.

Introduction

There are significant disparities in surgical access and outcomes between high-income countries (HIC) and low-income and middle-income countries (LMIC) [1]. The global burden of surgical emergencies is highest in LMIC, with a twofold to threefold higher surgical mortality [2]. In rural sub-Saharan Africa, the peritonitis and bowel obstruction incidences are unknown, but are estimated in a systematic review to be as high as 1364 per 100,000 persons for those who present with an acute abdomen [3].

Anthony Charles
anthchar@med.unc.edu

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

[2] School of Medicine, University of California San Francisco, San Francisco, California, USA

[3] Kamuzu Central Hospital, Lilongwe, Malawi

Mortality from peritonitis ranges from less than 5% in HIC compared to rates as high as 20% in LMIC [2, 4].

Malawi, a country in Southeast Africa, is a reasonable proxy for the rurality and healthcare structure typically seen in sub-Saharan Africa, with similar challenges in health and surgical care delivery. Malawi has a tiered health delivery system with points of access at the primary (clinics and health centers), secondary (district general hospitals), and tertiary level (highest level of care within major urban centers) [3]. A significant gap in the health workforce exists. As of 2016, there were 0.157 medical doctors per 10,000 population in Malawi [5]. Similarly, there were 0.908 and 0.399 doctors per 10,000 persons in Uganda and Tanzania. In contrast, the USA and Great Britain in 2016 had 25.9 and 28.1 medical doctors per 10,000 population, respectively [6].

There have been multiple adaptations made within local healthcare systems in LMIC to address the surgical workforce gap. These include task shifting to non-physician providers and implementing collaborative efforts to increase surgical workforce capacity through the creation of surgical training programs for physicians and non-physicians alike [7]. At the district hospital level, there has been increased interest in improving surgical capacity in part due to the relative success of their provision of basic obstetric surgical interventions (e.g., cesarean sections) [8, 9]. Malawi is no exception. An accredited surgical resident training program was established at KCH in July 2009, and efforts have been made to increase clinical officer capacity nationally [10].

With these changes, we would expect improvements in patient outcomes for common general surgical conditions, such as acute abdominal emergencies, reflecting a reduction in the barrier to timely access to safe surgical care [11, 12]. Therefore, we sought to examine the effect of surgical capacity at the district general hospital level on patient presentation and outcomes at a tertiary hospital, using referral patterns from the district hospitals in central Malawi.

Methods

We performed a retrospective analysis of the prospectively collected Kamuzu Central Hospital (KCH) Acute Care Surgery (ACS) database from September 2014 to August 2019. All patients presenting to KCH with acute care general surgery conditions are included in the KCH ACS database. Included in this study were all adult patients ($\geq$12 years old) who presented with an acute surgical abdomen (intestinal volvulus, peritonitis, perforated viscus, acute appendicitis, bowel obstruction, and incarcerated and strangulated hernia). Traumatic injuries were excluded as their pathway to care is better streamlined. Patients with other acute care surgical diagnoses were excluded.

KCH is a 900-bed tertiary hospital located in Lilongwe, Malawi. It is the referral center for eight district hospitals in central Malawi, with a catchment population of six million persons. At the start of the study, there were three general surgery consultants. By the end of the study, six general surgeon consultants, 11 general surgery residents, six surgical clinical officers in four operating rooms provided general surgical care. Clinical officer anesthetists provide anesthesia care. KCH has two surgical wards, a five-bed high dependency unit and a five-bed intensive care unit which are shared by medical and surgical patients.

Admission diagnoses were categorized as generalized peritonitis (gastric perforation and intestinal perforation) acute appendicitis, bowel obstruction, irreducible hernia (inguinal, umbilical, and ventral hernia), and intestinal volvulus (sigmoid, midgut, compound, and cecal volvulus).

Univariate analysis was performed to identify data distribution and evaluate missing data. Bivariate analysis was stratified over in-hospital mortality and year of presentation. Measures of central tendency were described in means with standard deviations and medians with interquartile ranges for normally and non-normally distributed data, respectively. χ^2 for categorical variables, Student's t test for normally distributed continuous variables, and Kruskal–Wallis for non-normally distributed continuous variables were performed to compare demographic and outcomes distribution in bivariate analysis.

To calculate the risk-adjusted mortality over the study period, we performed a Poisson multivariate regression to adjust for mortality confounders. The model included sex, age, transfer, and admission diagnosis a priori. Based on a significant p value ($<$0.05), the covariate, days to the operating room, was included in the model. A change-in-effects method was used to remove covariates, which did not significantly change the relationship between the year of patient presentation and mortality. The variable, days from the start of symptoms to presentation, was removed based on this criterion. From this model, we report a mortality risk ratio, 95% confidence interval, and p value.

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

Results

During the study period, the ACS database included 3832 patients. Of these, 3687 (96.2%) were patients ≥12 years of age. On admission, 2509 (68.0%) were diagnosed with an acute abdomen. In the overall cohort, the average age was 40.2 (SD 17.2 years), and the minority were female (n = 676, 26.0%). The majority of patients were transferred from outside hospitals (n = 2097, 83.9%), the majority being from district hospitals (n = 1165, 66.3%), and subsequently received an operation (n = 1787, 71.3%). Patients who are transferred to KCH undergo surgical procedures sooner than those who are not transferred at 0 days (IQR 0–1) and 1 days (IQR 0–2), respectively ($p < 0.001$). The primary admission diagnosis was bowel obstruction (n = 1147, 45.7%), followed by generalized peritonitis (n = 536, 21.4%) (Table 1).

Of the included patients, 415 (16.6%) patients died during their hospitalization. Those who died were older than the cohort who survived (45.6 SD 19.0 vs. 39.2 SD 16.6 years, $p < 0.001$), were more likely female (n = 132, 31.1% versus n = 545, 25.1%, p = 0.009), and less likely to undergo an operative intervention (n = 273, 65.5% vs. n = 1514, 72.4%, p = 0.004). Of the cohort who died, the primary admission diagnoses were bowel obstruction (n = 214, 51.3%) and peritonitis (n = 119, 28.5%) (Table 1).

On bivariate analysis over the year of patient presentation, there was no statistical difference in patient age, sex, or days from the start of symptoms to the patient's presentation at Kamuzu Central Hospital. The rate of operative intervention declined over time, from 319 (76.5%) in 2014 to 302 (68.3%) in 2019 (Table 2). The predominant admission diagnosis was bowel obstruction, followed by generalized peritonitis, over the entire study period. There was no statistical difference in mortality by the year of patient presentation, with the highest and lowest in 2018 (n = 97, 18.8%) and 2016 (n = 49, 13.4%), respectively (Fig. 1).

Upon Poisson regression analysis, there was no statistically significant change in the relative risk of mortality by year over the study period when controlling for confounding covariates. Other important factors increasing the relative risk of mortality were being transferred from an

Table 1 Univariate and bivariate analysis over patient mortality

	Overall (n = 2509)	Survived (n = 2092, 83.4%)	Died (n = 417, 16.6%)	p value
Age (years): μ ± SD	40.2 ± 17.2	39.2 ± 16.6	45.6 ± 19.0	<0.001
Female sex: n (%)	648 (25.0)	521 (24.9)	127 (30.5)	0.02
Surgery: n (%)	1787 (71.3)	1514 (72.4)	273 (65.5)	0.004
Transferred: i (%)	2097 (83.9)	1722 (82.6)	375 (90.1)	<0.001
Days to presentation: median (IQR)	3 (2–7)	3 (1–6)	4 (2–8)	<0.001
Days to operating room: n (%)				<0.001
0 days	955 (38.1)	838 (40.2)	117 (28.1)	
1–3 days	603 (24.1)	487 (23.3)	116 (27.8)	
≥4 days	946 (37.8)	762 (36.5)	184 (44.1)	
Admission diagnosis: n (%)				<0.001
Peritonitis	536 (21.4)	417 (19.9)	119 (28.5)	
Appendicitis	215 (8.6)	204 (9.8)	11 (2.6)	
Bowel obstruction	1147 (45.7)	933 (44.6)	214 (51.3)	
Irreducible hernia	337 (13.4)	315 (15.1)	22 (5.3)	
Volvulus	274 (10.9)	233 (10.7)	51 (12.2)	
Year: n (%)				0.1
2014	417 (16.6)	353 (16.9)	64 (15.4)	
2015	386 (15.4)	315 (15.1)	71 (17.0)	
2016	365 (14.6)	316 (15.1)	49 (11.8)	
2017	382 (15.2)	328 (15.7)	54 (13.0)	
2018	516 (20.6)	419 (20.0)	97 (23.3)	
2019	443 (17.7)	361 (17.3)	82 (19.7)	
Shock index: median (IQR)	1.30 (1.08–1.41)	1.33 (1.11–1.62)	1.16 (0.92–1.41)	<0.001
Hospital length of stay: median (IQR)	6 (3–9)	6 (4–9)	5 (2–10)	<0.001

Table 2 Bivariate analysis over year of patient presentation

	2014 (*n* = 417, 16.6%)	2015 (*n* = 386, 15.4%)	2016 (*n* = 365, 14.6%)	2017 (*n* = 382, 15.2%)	2018 (*n* = 516, 20.6%)	2019 (*n* = 443, 17.7%)	p value
Age: μ ± SD	39.4 ± 17.5	40.8 ± 17.1	41.6 ± 17.1	40.2 ± 16.9	39.3 ± 17.1	40.5 ± 17.5	0.4
Female sex: *n* (%)	125 (30.0)	104 (26.9)	95 (26.0)	86 (22.5)	130 (25.2)	108 (24.4)	0.2
Transferred: *n* (%)	355 (85.1)	337 (87.5)	328 (89.9)	334 (87.9)	408 (79.8)	335 (75.6)	<0.001
Had surgery: *n* (%)	319 (76.5)	288 (74.6)	253 (69.3)	268 (70.2)	357 (69.2)	302 (68.3)	0.04
Days to presentation: median (IQR)	3 (2–7)	4 (2–8)	3 (2–6)	3 (2–7)	3 (1–7)	3 (2–6)	0.1
Days to operating room: median (IQR)	0 (0–1)	0 (0–1)	0 (0–1)	1 (0–1)	1 (0–1)	1 (0–1)	<0.001
Transfers operated on within 24 h: *n* (%)	183 (68.8)	155 (61.8)	133 (56.8)	105 (45.7)	145 (49.0)	122 (46.0)	<0.001
Admission diagnosis: *n* (%)							<0.001
Peritonitis	98 (23.5)	77 (20.0)	45 (12.3)	100 (26.2)	132 (25.6)	84 (18.9)	
Appendicitis	28 (6.7)	27 (7.0)	27 (7.4)	44 (11.5)	53 (10.3)	36 (8.1)	
Bowel obstruction	161 (38.6)	179 (46.4)	190 (52.1)	139 (36.4)	228 (44.2)	250 (56.4)	
Irreducible hernia	79 (18.9)	65 (17.0)	46 (12.6)	41 (10.7)	56 (10.9)	50 (11.3)	
Volvulus	51 (12.2)	38 (9.8)	57 (15.6)	58 (15.2)	47 (9.1)	23 (5.2)	
Died: *n* (%)	64 (15.4)	71 (18.4)	49 (13.4)	54 (14.1)	97 (18.8)	82 (18.5)	0.1

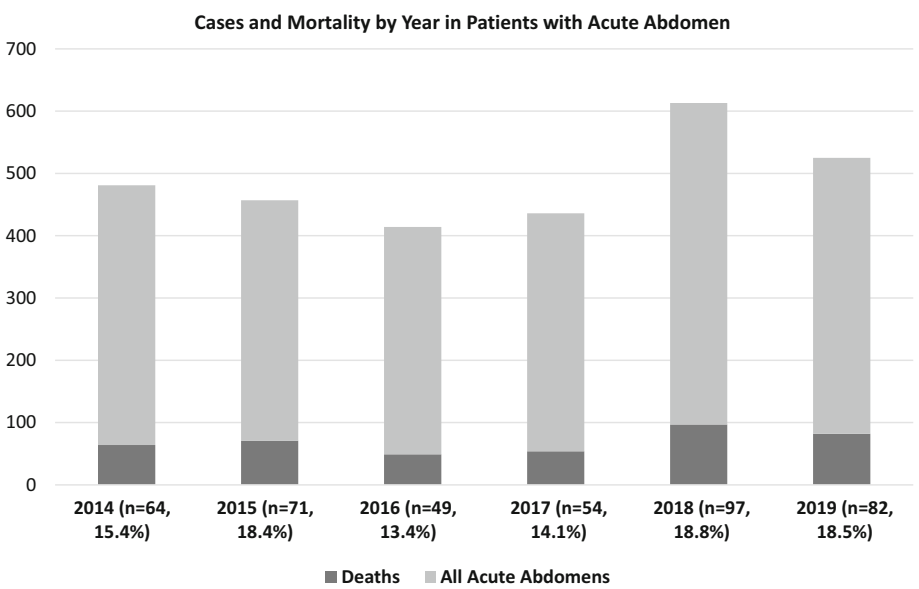

Fig. 1 Cases and mortality by year in patients with acute abdomen showing no statistical difference in mortality by year ($p = 0.1$)

outside hospital (RR 1.31, 95% CI 1.12–1.55, $p = 0.002$), as well as undergoing an operation within 1–2 days (RR 1.48, 95% CI 1.16–1.87, $p < 0.001$) and greater than 2 days (RR 1.46, 95% CI 1.17–1.82, $p = 0.001$) after presentation. When compared to hernias, patients presenting with peritonitis (RR 3.46, 95% CI 2.25–5.31, $p < 0.001$), intestinal volvulus (RR 2.61, 95% CI 1.63–4.19, $p < 0.001$), and bowel obstruction (RR 2.41, 95% CI 1.58–3.68, $p < 0.001$) had an increased relative risk of mortality.

Discussion

In this study, we showed that over a 5-year period, the overall mortality for patients presenting with an acute abdomen was 16.6% at a tertiary hospital in Malawi. Greater than 75% of patients presenting to KCH with an acute abdomen were transferred, with 63% from district hospitals. There was an increased relative risk of mortality for patients transferred to our center and those with a delay to the operating room greater than 24 h. There was no difference in adjusted annual mortality at KCH over the study period when controlling for pertinent covariates.

The high mortality shown in this study is attributable to the three leading etiologies of acute abdomen at KCH, peritonitis (28.5%), bowel obstruction (22.9%), and volvulus (21.9%). Our overall mortality for patients presenting with acute abdomen is similar to studies performed in comparable LMIC hospitals in Rwanda, Ethiopia, and Pakistan at approximately 15–17% [13–15]. Globally, a systematic review of emergency abdominal surgeries found a 14.9% mortality for all midline exploratory laparotomies performed in LMIC [2]. Deaths due to acute abdomen vary by etiology in the region. The mortality from peritonitis and volvulus is nearly 20% [2, 16, 17]. These reported outcomes are much higher than the 5% mortality from peritonitis seen in high-income countries [2].

Throughout this study, KCH has developed a mature surgical residency program, training 2–3 general surgeons per year. As a result, the number of consultant general surgeons at KCH has doubled over the study period. Though the number of trained surgeons practicing at KCH has dramatically improved, there has been no improvement in mortality for common acute abdominal emergencies seen at KCH. A primary reason for the lack of improvement in mortality in our study is the overwhelming role of pre-hospital delays and the relationship between pre-hospital delays and increased time from clinical symptoms to operative intervention. Delays in urgent and emergent surgical care result in physiologic derangements, which increased surgical morbidity and mortality [18]. Greater than 75% of patients presenting to KCH with an acute abdomen were transferred from outside hospitals for surgical management. Throughout this study period, there has been no organized effort to reduce transfer times from the district hospitals to the receiving hospitals (Table 3).

In this study, modifiable risk factors which increased the relative risk of mortality were transferred from an outside hospital and in-hospital delay to surgical intervention greater than 24 h after hospital admission. Addressing these factors is imperative in Malawi to improve patient outcomes and decrease mortality. Furthermore, expanding surgical care to the district hospitals and establishing an inter-hospital transfer system are interventions that may reduce delays to surgical intervention.

During the study period, there has been no investment or improvement in surgical capacity at the district hospital level. Currently, Malawian district hospitals are primarily staffed by clinical officers with physicians mostly in non-clinical, administrative roles. Also, there is a paucity of general surgery being performed, as evidenced by the large proportion of emergent general surgical procedures being transferred to KCH. A target of the Lancet 2030 Commission is to have 80% of district and central hospitals providing Bellwether procedures by 2030 [19]. The Bellwether procedures include laparotomy, treatment of open fractures, and cesarean delivery. These procedures encompass a significant proportion of the treatment for surgical conditions, and the ability to perform these operations closely predicts the ability to deliver essential surgical care. The ability to competently and safely perform these procedures is critical to reducing surgical mortality [9].

Currently, based on the quality and quantity of surgical care delivery at district hospitals, Malawi is not on track to meet WHO's Bellwether standards. Studies across the region show a deficit in the capacity of district hospitals to perform laparotomies [20–23]. In a Ghanaian study examining district hospital surgical capacity, 2/3 of all procedures performed at the district hospitals were for obstetrics and gynecology indications. Minimal general surgery procedures were performed, with the vast majority being inguinal herniorrhaphy [20]. In this study, there were high rates of patient transfers due to a lack of equipment, supplies, or surgical skills, as none of the medical officers at any of the district hospitals had any surgical training [20]. In a survey performed nationally in Malawi, similar results were seen. Of the operations performed, 50% were for cesarean sections and dilation and curettage. Only 15% of laparotomies and 28% of herniorrhaphy were completed at district hospitals, reportedly due to lack of confidence in both laparotomy skills and perioperative management of general surgical conditions encountered [23]. These studies highlight the dissonance between the institutional capability to perform a cesarean section and the ability to competently and confidently complete general surgery laparotomies.

Creating a sustainable surgical ecosystem at the district general hospital level will attract general surgeons and enhance the training of clinical officers to deliver surgical care, particularly the Bellwether procedures. This will have the potential to reduce inter-hospital transfers twofold [24]. Furthermore, improving surgical capacity at the district hospital level will bring surgical care closer to the rural population in need and improve central hospital care by reducing the patient and operative burden, which in turn

Table 3 Multivariate Poisson regression predicting the relative risk of mortality

	Relative risk	95% Confidence interval	*p* value
Sex	1.16	0.97–1.40	0.1
Age	1.02	1.01–1.02	<0.001
Transfer	1.31	1.10–1.55	0.002
Days to operating room			
Same day	Ref	–	–
1–2 days	1.48	1.17–1.88	<0.001
3 Days or greater	1.46	1.16–1.80	0.001
Year			
2014	Ref	–	–
2015	1.17	0.86–1.58	0.3
2016	0.83	0.59–1.16	0.3
2017	0.84	0.61–1.16	0.3
2018	1.15	0.86–1.52	0.3
2019	1.15	0.86–1.55	0.3
Admission diagnosis			
Hernia	Ref	–	–
Peritonitis	3.46	2.25–5.31	<0.001
Appendicitis	0.92	0.46–1.87	0.8
Bowel obstruction	2.41	1.58–3.68	<0.001
Volvulus	2.61	1.63–4.19	<0.001

will reduce the cancellation rate of elective surgeries at the central hospital level [25]. Investing in district hospital care is also cost-effective. In Niger, Santi et al. showed training general practitioners in general surgery at district hospitals led to an 82% reduction in transfers to the tertiary hospital 2 years after the training [24]. The cost per DALY prevented by investing in general surgery capacity at the district hospital level is $33 compared to the World Health Organization threshold for the affordability of an intervention, set at $150 per DALY averted, or three times the per capita gross national income per DALY saved [26–28].

Although our acute general surgery cohort did not examine patients presenting with trauma, a formalized inter-hospital transfer system has the potential to improve outcomes for both trauma and acute care general surgery patients. Currently, Malawi does not have an established pre-hospital emergency medical service system. The majority of ambulances in the country are used for inter-hospital transfers. In a study comparing trauma systems, pre-hospital deaths are shown to be inversely correlated with the maturity of the pre-hospital system [29]. Establishing a pre-hospital trauma system in a developing country has shown to decrease mortality by up to 25% [30]. Countries with trauma systems generally have improved pre-hospital systems that improve care for all patients. Pre-hospital systems can establish networks of healthcare centers to streamline acute care surgery transfers and reduce transfer time between the district and central hospitals. Therefore, by reducing pre-hospital delays, a resulting reduction in mortality is possible. The development of such a system in the USA reduced mortality from 4.9% to 1.3% over 5 years [31].

In-hospital delays to urgent and emergent surgery greater than 24 h can increase the relative risk of patient mortality by 68% [32]. Between 2017 and 2018, KCH underwent concurrent renovations of all of its general surgical operating rooms. Only urgent and emergent general surgical cases were performed in operating rooms shared with obstetrics and gynecology. During this time, the proportion of patients undergoing operations decreased, the days to operation increased, and absolute acute abdomen mortality increased. Unfortunately, these types of delays to surgical intervention in LMIC are common. Studies in both Nigeria and the Ivory Coast show more than 50% of non-elective surgeries are delayed greater than 24 h [33, 34]. An assessment of in-hospital delays to operative intervention is warranted to improve surgical outcomes and is necessary to implement quality improvement programs. In Thailand, interventions put in place to address in-hospital surgical delays, such as increasing numbers of experienced staff in casualty and improved hospital communications, nearly halved the mortality of

surgical emergencies by improving resuscitation and decreasing the in-hospital time to the operation room [35].

This study has several limitations related to its retrospective methodology. This is a single institution study with unique surgical capacity that may limit the generalizability of our findings. Second, due to difficulties in data collection in this setting, we lack essential variables such as critical illness severity or time from symptoms to presentation. Lastly, limitations exist in the ability to control for selection bias and confounding variables.

Future studies in Malawi need to be directed toward surgical capacity at the district hospital level. Research studies will be imperative to identify deficits in surgical capacity, beyond the inability to provide surgical care for the Bellwether procedures and challenges in inter-hospital transfer. In addition, this will better direct Ministry of Health and non-governmental organization investments to improve clinical officer and surgical training, as well as to optimize surgical capacity.

Conclusion

We show acute abdomen mortality is high at a tertiary hospital in Malawi and is unchanged despite the presence of a mature general surgery residency program and a full staff of consultant surgeons. Acute abdominal conditions are time sensitive, and access to surgical facilities with the capacity to deliver operative intervention is crucial for reducing delays to definitive surgical care and associated mortality. High transfer rates from district hospitals and in-hospital delays to operative intervention are risk factors for increased mortality. Investing in surgical care at district hospitals and developing an inter-hospital transfer system is imperative to reducing surgical mortality.

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