


Factors associated with mortality in congenital malformations of the gastrointestinal tract in a tertiary center in Senegal

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ABSTRACT

Objective Patients with congenital malformations (CMs) of the gastrointestinal tract (GIT) have a very high mortality. However, the literature on the factors associated with mortality in these patients is scarce in sub-Saharan Africa. The aim of this study is to identify independent risk factors for mortality in patients with CMs of the GIT at our pediatric surgical department.

Methods We conducted a retrospective analysis of cases with CMs of the GIT managed at a tertiary center from 2018 to 2021. Patients were subdivided into two groups based on the outcomes, and variables with a significant difference were analyzed by logistic regression.

Results Our review included 226 patients, 63 of whom died (27.88%). Patient age ranged from 0 to 15 years. Taking into account statistical significance, mortality was more frequent in neonates than in older patients (57.30% vs 6.15%), in patients coming out of the Dakar area than in those from the Dakar area (43.75% vs 19.18%), in patients with abnormal prenatal ultrasound than in those with normal ultrasound (100% vs 26.67%), in premature children than in those born at term (78.57% vs 21.87%), in patients with an additional malformation than in those with an isolated malformation (69.23% vs 25.35%), and in those with intestinal, esophageal, duodenal and colonic atresia than in those with other diagnoses (100%, 89%, 56.25% and 50%, respectively). Referred patients died more than those who changed hospitals or came from home (55.29% vs 25% and 9.09%, respectively). On multivariable logistic regression, two independent factors of mortality were identified: presence of associated malformation [odds ratio (OR)=13.299; 95% Confidence interval (CI) 1.370 to 129.137] and diagnosis of esophageal atresia (OR=46.529; 95% CI 5.828 to 371.425).

Conclusion The presence of an associated malformation or diagnosis of esophageal atresia increases mortality in patients with CMs of the GIT in our environment.

INTRODUCTION

Congenital malformations (CMs) represent a large burden of pediatric surgical disease in African tertiary centers.^{1,2} CMs are the third leading cause of death among children aged

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Perioperative mortality of congenital gastrointestinal malformation is very high in low and middle-income countries. However, local studies of its risk factors are scarce.

WHAT THIS STUDY ADDS

⇒ In Senegalese children, esophageal atresia and associated malformation multiply the risk of mortality in congenital gastrointestinal malformations by 46 and 13, respectively.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Early diagnosis and management of esophageal atresia and management of polymalformation in well-equipped neonatal intensive care units should be attempted.

less than 5 years worldwide.³ Malformations of the gastrointestinal tract (GIT) are the third most common CM.⁴ In high-income countries (HICs), these malformations are more frequently diagnosed prenatally or during the neonatal period with early management in dedicated centers and with improved survival during the last decades.^{5,6} However, prenatal diagnosis of GIT malformations is rare in low and middle-income countries (LMICs).^{5,6} Postnatal diagnosis is often delayed, and the resulting mortality is very high compared with HICs.⁶

The global mortality of CMs of the GIT in LMICs is 39.8%, while it is only 5.6% in HICs.⁶ However, some conditions have a very high contrast in mortality rate. This is the case for esophageal atresia (EA), for which mortality is 85.7% in LMICs versus 7.2% in HICs.⁶ Many reasons have been advocated to justify this difference. However, in sub-Saharan Africa, studies on risk factors for mortality from GIT malformations are scarce.⁷ In Senegal, the

Table 1 Characteristics of patients by survival status and analysis of differences

	All patients (n=226)	Mortality		P value
		Yes (n=63)	No (n=163)	
Neonate				< 0.001*
Yes	96	55 (57.3)	41 (42.7)	
No	130	8 (6.15)	122 (93.85)	
Sex				0.449*
Males	136	37 (27.21)	99 (72.79)	
Females	90	26 (28.89)	64 (71.11)	
Origin				< 0.001*
Dakar	146	28 (19.18)	118 (80.82)	
Other	80	35 (43.75)	45 (56.25)	
Prenatal ultrasound				0.002†
Abnormal	6	6 (100)	0	
Not done	9	4 (44.44)	5 (55.56)	
Normal	30	8 (26.67)	22 (73.33)	
Not reported	181	45 (24.84)	136 (75.14)	
Gestational age at birth				0.002†
Prematurity	14	11 (78.57)	3 (21.43)	
Postmaturity	2	1 (50)	1 (50)	
Not reported	178	44 (24.72)	134 (75.28)	
Normal	32	7 (21.87)	25 (78.13)	
Associated malformation				0.002‡
Yes	13	9 (69.23)	4 (30.77)	
No	213	54 (25.35)	159 (74.65)	
Diagnosis				< 0.001†
Intestinal atresia	5	5 (100)	0	
Esophageal atresia	37	33 (89.19)	4 (10.81)	
Duodenal atresia	16	9 (56.25)	7 (43.75)	
Colonic atresia	2	1 (50)	1 (50)	
Anorectal malformation	69	9 (13.04)	60 (86.96)	
Malrotation	29	3 (13.04)	26 (86.96)	
Hirschsprung's disease	64	3 (4.69)	61 (95.31)	
Congenital esophageal stenosis	4	0	4 (100)	
Year of admission				0.064*
2018	53	9 (16.98)	44 (83.02)	
2019	72	19 (26.39)	53 (73.61)	
2020	101	35 (34.65)	66 (65.35)	
Mode of admission				< 0.001*
Referral	45	47 (55.29)	38 (44.71)	
Mutation	20	5 (25)	15 (75)	
Home	121	11 (9.09)	110 (90.91)	
Parental consanguinity				0.098*
Yes	21	9 (42.86)	12 (57.14)	
No	64	21 (32.81)	43 (67.19)	
Not reported	141	33 (23.4)	108 (76.6)	

Bold denotes statistically significant difference.

Data were presented as number (percentage).

*Pearson's χ^2 test.

†Monte Carlo's exact test.

‡Fisher's exact test.

Table 2 Logistic regression analysis for risk factors of mortality in patients with CMs of the GIT

Variable	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Neonate				
No	Ref		Ref	
Yes	20.457 (8.995 to 46.528)	< 0.001*	1.353 (0.340 to 5.382)	0.668
Dakar				
Yes	Ref		Ref	
No	3.278 (1.792 to 5.997)	< 0.001*	2.347 (0.820 to 6.717)	0.112
Prenatal ultrasound				
Not reported	Ref		Ref	
Normal	1.099 (0.457 to 2.641)	0.833	0.713 (0.045 to 11.401)	0.811
Abnormal	4.8E9 (0.000)	0.999	6.580E9 (0.000)	0.999
Not done	2.418 (0.622 to 9.395)	0.202	1.237 (0.132 to 11.639)	0.852
Gestational age at birth				
Normal	Ref			
Prematurity	13.095 (2.844 to 60.303)	0.001*	17.151 (0.946 to 310.999)	0.055
Postmaturity	3.571 (0.197 to 64.632)	0.389	1.420 (0.005 to 427.706)	0.904
Not reported	1.173 (0.475 to 2.898)	0.730	5.208 (0.300 to 90.537)	0.257
Associated malformation				
No	Ref		Ref	
Yes	6.625 (1.961 to 22.386)	0.002*	13.299 (1.370 to 129.137)	0.026
Hirschsprung's disease				
No	Ref			
Yes	0.084 (0.025 to 0.278)	< 0.001*	0.881 (0.133 to 5.831)	0.896
CES				
No	Ref			
Yes	0.999 (0.000)	< 0.001*	0.000 (0.000)	0.999
Anorectal malformation				
No	Ref			
Yes	0.286 (0.132 to 0.620)	0.002*	1.238 (0.240 to 6.387)	0.798
Duodenal atresia				
No	Ref			
Yes	3.714 (1.319 to 10.457)	0.013*	3.274 (0.446 to 24.028)	0.243
Intestinal atresia				
No	Ref			
Yes	45E7 (0.000)	0.999	66E8 (0.000)	0.999
Colonic atresia				
No				
Yes	2.613 (0.161 to 42.423)	0.499	7.689 (0.179 to 329.362)	0.287
Malrotation				
No				
Yes	0.263 (0.077 to 0.904)	0.034*	1.003 (0.101 to 5.342)	0.920
Esophageal atresia				
No				
Yes	43.725 (14.430 to 132.491)	< 0.001*	46.529 (5.828 to 371.425)	< 0.001
Admission mode				
Home	Ref			

Continued

Table 2 Continued

Variable	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Referral	12.368 (5.825 to 26.262)	< 0.001*	3.387 (0.858 to 13.369)	0.082
Mutation	3.333 (1.017 to 10.922)	0.047*	0.866 (0.115 to 6.544)	0.899

*Statistically significant on unadjusted (univariate) logistic regression. Bold denotes statistically significant on adjusted (multivariate) logistic regression.
CES, congenital esophageal stenosis; CI, confidence interval; OR, odds ratio; Ref, reference.

mortality of several GIT malformations was reported to be very high.^{8–12} We assume that the identification of independent factors of mortality in patients with CMs of the GIT will allow a better understanding of mortality in this group of children and therefore lead to the improvement of care for better survival. With this review, our aim was to identify risk factors for mortality in patients with CMs of the GIT admitted at our University Teaching Hospital (UTH), Albert Royer National Children's Hospital Center in Dakar, the capital city of Senegal.

METHODS

Study design

We conducted a retrospective review at the pediatric surgery department of our UTH, Albert Royer National Children's Hospital Center in Dakar, Senegal. With two other tertiary hospitals, our department is the main pediatric surgical unit of Senegal, providing surgical care to Senegalese children, as well as those from neighboring countries (Gambia, Guinea and Mauritania).

Study participants

We considered patients admitted for CM of the GIT between 1 January 2018 and 1 January 2021. Patients whose medical records could not be retrieved or were referred to another hospital for management were excluded from this review. Patients' medical records were retrieved from patients' medical files, operating room registers, and the hospital's informatics services.

Collected data were sociodemographic (age at diagnosis, sex, geographic origin), diagnostic (prenatal ultrasound (US), gestational age at birth, type of CM of the GIT), and associated malformation, which was defined as presence of additional malformation to the digestive one. In case the associated malformation is digestive too, the most life threatening was considered as the diagnosed malformation, and the less threatening malformation is considered as the associated malformation or outcome (mortality). They were first registered on a predesigned printed sheet before being encoded using an Excel spreadsheet (Microsoft Office 2019).

Among the 242 patients, 16 were excluded from the present study: 10 due to lack of pathology results in suspected Hirschsprung's disease (HD), 5 for missing information about patients' age at diagnosis, sex and outcome, and 1 for missing information about the patient's sex.

Statistical analysis

Patients were divided into two groups according to the outcome: mortality and survival group. Qualitative data were expressed as frequencies when the mean and Standard deviation (SD) were calculated for quantitative data. Differences between the two groups were analyzed for significance using Pearson's χ^2 test, Monte Carlo's exact test or Fisher's exact test. Statistically significant variables were analyzed in logistic regression model with unadjusted and adjusted odds ratios (ORs) calculated. The level of significance was set at p value <0.05. Data were analyzed with SPSS V.26.0 (IBM SPSS Statistics V.26). Factors studied included being a neonate, originating out of Dakar, having abnormal prenatal US, prematurity, having an associated malformation, diagnosis, and previously leaving a hospital against medical advice.

RESULTS

From 2018 to 2021, among 3667 patients admitted to our department, 242 had CM of the GIT, implying a frequency of 6.6% at our institution. Among the 242 patients, 16 were excluded from the present study.

In this study, the patients' ages ranged from 0 to 15 years; neonates represented 42.48%, and males represented 60.18%, with a sex ratio of 1.5:1. Concerning the origin of patients, 64.60% of them were from Dakar and its neighborhood. Parental consanguinity status was reported in 85 cases (37.61%), of whom 24.71% of patients were issued from a consanguineous marriage. Status of prenatal US was reported in 19.91% of cases, of which 13.33% were abnormal, 20% were not done and 66.67% were normal. The gestational age at birth was reported in 48 patients (20.24%), of whom 29.17% noted prematurity, 4.17% noted postmaturity, and 66.66% noted normal gestational age at birth. CMs of the GIT were isolated in 94.25% of cases. Malformations encountered included anorectal malformation in 30.53%, HD in 27.88%, EA in 16.37%, malrotation in 12.83%, duodenal atresia (DA) in 7.08%, intestinal atresia in 2.21%, congenital esophageal stenosis in 1.77%, and colonic atresia (CA) in 0.88%. The admission rate progressively increased from 2018 to 2020 with 53, 72, and 101 cases, respectively. A total of 85 patients (37.61%) were referred, 53.54% came from home, and 8.85% changed the hospital based on parental decisions, that is, self-referral.

Among our population study, 63 deaths (27.88%) were registered. Analysis of differences between the mortality

and survival groups showed no significance for sex, parental consanguinity or year of admission. The variables between the two groups that were statistically significant included being a neonate ($p < 0.001$), geographical origin ($p < 0.001$), prenatal US status ($p = 0.002$), gestational age at birth ($p = 0.002$), presence of an associated malformation ($p = 0.002$), diagnosis ($p < 0.001$), and admission mode ($p < 0.001$). These results are presented in [table 1](#).

Variables that showed a significant difference between the two groups were considered for logistic regression analysis. Unadjusted OR showed significance for being a neonate, originating out of Dakar, prematurity, presence of an associated malformation, and some diagnoses, such as DA, CA and EA, for two admission modes: referral and self-referral. Finally, based on adjusted OR, two variables showed statistically significant differences: the presence of associated malformation increased the risk of mortality by 13 ($p = 0.026$), while the diagnosis of EA increased the risk of mortality by 46 ($p < 0.001$), as represented in [table 2](#).

DISCUSSION

Our study retrospectively reviewed 226 cases of CMs of the GIT, of whom approximately a quarter died. This mortality rate is similar to those of other LMICs, as some authors reported mortality ranging from 19.23% to 50%.^{6 13–16} This is far less than the approximately 5% mortality rate reported in Western studies.⁶ In a recent review, originating from a low-income country was identified as an independent risk factor for mortality in CMs of the GIT, increasing the risk by approximately three-fold compared with patients from HICs.⁶ Several reasons have been pointed out to explain this difference. These include lack of prenatal diagnosis, unavailability of pediatric anesthesiologists, lack of surgical safety checklists, unavailability of ventilation, and high cost of parenteral nutrition (PN), which makes it unavailable for many patients in need.⁶ Other possible factors are delayed referral to tertiary hospitals, inappropriate medical transfer of patients, and inadequate resuscitation during the transfer and on admission at the referral hospital.⁷

We found that EA was independently associated with increased mortality, increasing it by approximately 46 times. In previous studies in Senegal, the mortality of this condition was very high; for example, in previous decades, it was nearly 100%.¹⁷ In the last decade, mortality decreased to 73%–80%,^{9 11 17} which is still very high compared with HICs, where mortality reaches 7%.⁶ Reasons for this high mortality in our environment were identified by some earlier studies, including lack of prenatal diagnosis, which leads to birth out of tertiary centers, which in turn leads to delayed diagnosis and management, since patients should be referred.^{5 11 17 18} Delayed diagnosis exposes newborns to pulmonary compromising due to frequent episodes of choking, which leads to permanent respiratory distress, found in 40% of patients in a local

study.⁹ The lack of surgical neonatal intensive care units (NICUs), with the hospitalization of newborns in medical NICUs, also increases mortality in our settings.^{17 19}

We highlighted that patients with associated malformations had a 13-fold likelihood of death. This may be linked to the severity of associated anomalies, which lead to more complex management, considering the lack of well-equipped NICUs in our context, as well as elsewhere in sub-Saharan Africa.^{15 19 20}

Additionally, some factors frequently associated with mortality in several studies were not shown to be independent risk factors for mortality in our review. The first is being neonate. In fact, several authors have reported a higher mortality rate in neonates than in older patients.^{14 19} However, another study did not find it to be an independent factor of mortality.²¹ A recent Somali study showed improved neonatal perioperative survival compared with other African settings. However, the highest mortality rate was found in patients with EA.²² High mortality in neonates should therefore be linked to the diagnosis, delayed presentation, subsequent complications, and lack or underequipment of NICUs.^{19 23–25} Second, we did not find the geographical origin of our patient to be an independent predictor of mortality, unlike other authors.⁶ This can be explained by the fact that the distance from the tertiary hospital can interact with other factors, such as medical transportation during the referral, quality of resuscitation prior to referral and severity of the diagnosis.

We included 226 patients out of the 242 identified during the study period. First, missing data on prenatal US and gestational age at birth did not allow better analysis of the link between these elements and mortality. Second, data on the condition of referral (medical or not), place of birth (tertiary center or not), need for ventilation (yes vs no), need for PN (yes vs no), qualification of anesthesiologist (resident vs consultant), and qualification of the main surgeon (resident vs consultant) were not analyzed in our review.

In conclusion, our study found that mortality in patients with CMs of the GIT was very high, as in other sub-Saharan tertiary centers. Two factors were independently associated with mortality in Dakar in these conditions: presence of an associated malformation and a diagnosis of EA. Patients with these elements should benefit from specific care from diagnosis to postoperative care. Future multicenter studies on predictors of mortality in EA and polymalformation are encouraged to improve survival in these patients in our milieu.

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