

## Neonatal gastro-intestinal tract perforation in Mosul city

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### ABSTRACT

**Background:** Gastro-intestinal perforation (GIP) of neonates considered as one of the foremost emergency problems faced by pediatric surgeons around the world. It represents important challenges with a high mortality of 15-70% has been reported. Despite enhancements in anesthesia, as well as, intensive care, mortality has remained high, especially in premature babies.

**Patients and Methods:** A retrospective series study including 50 patients diagnosed as GIT perforation were admitted to the neonatal pediatric surgery center in Al-Khansaa teaching hospital, allocated over the period extending from April 2017 to June 2019. Records were reviewed for the age, sex, gestational age, weight, duration of symptoms, associated anomalies, causes of GIT perforation, procedure done, mortality, morbidity, and hospital stay period. Leak from intestinal anastomosis secondary to resection as surgical interference were excluded from the study.

**Results:** The presentation age varied between 12 hours to 27 days with a median age of 3.5 days. The weight mean is 2.93 kg. The mean gestation age was 34 weeks, ranging from 30-42 weeks. The majority had the symptoms before 30 hours. Most of the sample is within the 1<sup>st</sup> week representing 86.0%. The males are representing 76.0% while the females are 24.0% with a ratio about of (3:1). About 56.0% of the perforations occur in the small bowel and only 4.0% in appendix. The large bowel represents 28.0% and the stomach 12.0%. The positive findings of abdominal X-Ray are found in 80.0% of patients. 40.0% of patients are died. The frequent site is the ileum, found in 8 patients (40.0%) of all deaths. Next are the Jejunum and colon, representing 20.0% for each. The stomach pathology found in 10.0%, as well as, the cecum 10.0%.

**Conclusion:** The commonest site of perforation is small bowel. History, clinical picture and erect abdominal X-ray are very important for the diagnosis. The risk factors raise the mortality rate include malnutrition, the appearance of complications, lack of certain drugs, delayed diagnosis, prematurity, and associated anomalies. The outcome is improved with early identification, diagnosis, and treatment.

**AIM OF THE STUDY :** To study the causes and outcome of neonatal GIT perforations in Mosul city and its drainage areas in the north of Iraq.

**Keywords :** Neonate , Bowel , Gastro-intestinal perforation .

### انتقاب المعدة او الأمعاء للأطفال حديثي الولادة في مدينة الموصل

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الاطفال ، الموصل ، العراق

### الخلاصة

يعتبر انتقاب المعدة او الامعاء للأطفال حديثي الولادة واحدا من أهم الحالات الطارئة التي تواجه جراحي الاطفال في العالم وهي بمثابة تحديات مهمة لهم و بنسبة وفاة مسجلة تتراوح بين ١٥-٧٠٪. وبالرغم من التقدم في التخدير و العناية المركزة، فان نسبة الوفيات لا تزال عالية، خاصة بين الاطفال الخدج.

**المرضى والطرق :** دراسة بأثر رجعي تشمل ٥٠ مريضا تم تشخيصهم بانتقاب المعدة أو الأمعاء وتم ادخالهم الى مركز جراحة الاطفال حديثي الولادة في مستشفى الخنساء التعليمي في الفترة الممتدة ما بين نيسان ٢٠١٧ الى حزيران ٢٠١٩. تم مراجعة

السجلات من اجل الحصول على العمر، الجنس، مدة الحمل، الوزن، الفترة الزمنية للاعراض، التشوهات المصاحبة، أسباب انتقاب المعدة او الامعاء، الاجراءات المتخذة، نسبة الوفيات و المضاعفات و فترة الإقامة في المستشفى.

**النتائج :** كانت أعمار المرضى تتراوح ما بين ثلاثة ايام الى سبعة و عشرون يوماً و بمتوسط عمر ٣.٥ يوم و كان متوسط الوزن ٢.٩٣ كغم. و كانت مدة الحمل تتراوح بين ٣٠ الى ٤٢ أسبوعاً و متوسط مدة الحمل ٣٤ أسبوعاً. أغلب هؤلاء الأطفال ظهرت عليهم الاعراض قبل الساعة الثلاثون من العمر ومعظم الحالات كانت في الأسبوع الأول من العمر (٨٦٪). كانت نسبة الذكور الى الاناث (٣ : ١) تقريباً بواقع ٧٦٪ للذكور و ٢٤٪ للإناث. كانت قرابة ٥٦٪ من حالات الانتقاب قد حدثت في الأمعاء الدقيقة و ٤٪ فقط في الزائدة الدودية بينما كانت نسبة انتقاب الأمعاء الغليظة ٢٨٪ و المعدة ١٢٪. أشعة البطن السينية كانت إيجابية في ٨٠٪ من الحالات. نسبة الوفاة كانت ٤٠٪ و حالات الوفاة الأكثر تكراراً كانت في اللفائفي و بواقع ٨ مرضى (٤٠٪ من الوفيات) ثم الصائم و الامعاء الغليظة (٢٠٪) لكل منهما، ثم المعدة و الاعور بنسبة وفاة (١٠٪) لكل منهما.

**الاستنتاجات :** انتقاب الأمعاء الدقيقة هو الأكثر شيوعاً. تاريخ المرض، العلامات السريرية و الأشعة السينية للبطن في حالة الوقوف من الأمور المهمة جداً في التشخيص. عوامل الخطورة التي ترفع معدلات الوفاة تتضمن سوء التغذية، ظهور المضاعفات، عدم توفر الأدوية المهمة، تأخر التشخيص، الولادات المبكرة للأطفال الخدج و التشوهات الولادية المصاحبة. يمكن تحسين النتائج بالتعرف، التشخيص و العلاج المبكر للمرض.

**الكلمات المفتاحية :** اطفال خدج ، انتقاب ، المعدة و الامعاء.

## INTRODUCTION

**G**astro-intestinal perforation (GIP) of neonates considered as one of the foremost emergency problems faced by pediatric surgeons around the world <sup>1</sup>. It represents imperative confronts with a high death rate of 15-70% .

Despite enhancements in anesthesia, as well as, intensive care, death rate has continued to be high, particularly in the pre-terms, in numerous developing countries, and there is no various information of GIP available from such regions <sup>2</sup>. This death rate depends on various bases such as number of perforation, birth weight, delayed presentation, and referral efficiency. However, detection at an early stage, diagnosis and quick transport of patients may have an excellent prognostic value <sup>3,4</sup>. Although bowel perforation of neonates may have many etiologies; spontaneous idiopathic perforation (SIP), secondary to Necrotizing enterocolitis (NEC) and mechanical obstruction etc <sup>5</sup>, the NEC is still the foremost cause of NGIP <sup>6</sup>. Other major causes are low birth weight, low gestational age, bottle feeding as a substitute of breastfeeding, fast and early raises in meal volume, and bowel ischemia <sup>7,8</sup>. The term spontaneous defined as a perforation that occurs in the GIT of a neonate without demonstrable reason that is characteristically presented in the terminal ileum <sup>9</sup>. Nevertheless found habitually in pre-term newborns with very low birth weight (VLBW) and extremely low birth weight (ELBW) due to the lack of gastric maturity and protective factors, such as lack of C-KIT mast cells and intestinal pacemaker cells, with the minority of cases have been expressed in full-term neonates

<sup>10-12</sup>. The causes, risk factors, as well as, pathogenesis of the GIP is mysterious and numerous theories were projected although none has been proven and the circumstances associated with neonatal hypoxia were the significant qualifications for this rising distinctive entity.

When the GIP was assumed clinically with presence of fever, dehydration and tense abdominal distention then plain chest X-ray in an upright position should be carried out in addition to plain abdominal X-ray <sup>13,14</sup>. This image illustrates a huge volume of gas beneath the diaphragm because of bowel perforation. Rigler sign may be seen as a sharp discrimination of the intestinal wall, habitually one of the earliest perforation signs. Football sign seen as a large circular or ovoid lucency above the liver or in the middle component of the abdomen due to a big quantity of free intra-peritoneal air with the falciform ligament was delineated because the air tends to present on its both sides. This is seen as a faint opacity of linear shape located along the right upper zone of abdomen, representing the seams or laces of an American football. Triangle sign can be found while free air collected and ensnared within the bowels' loops.

The management of GIP in neonates depends and related to the etiological factors and varies to incorporate primary repair of the bowel, resection with anastomoses, gastrectomy, gastro-duodenostomy, ileostomy, and colostomy <sup>2,15,16</sup>.

### Aim of Study

To study the causes and outcome of neonatal GIT perforation in Mosul city and its drainage areas in the north of Iraq.

### PATIENTS AND METHODS

In order to accomplish the study's aim, a retrospective study was adopted to and 50 patients diagnosed as GIT perforation were admitted to the neonatal pediatric surgery center in Al-Khansaa teaching hospital, allocated over the period extending from April 2017 to June 2019.

Records were reviewed for the age, sex, gestational age, weight, duration of symptoms, associated anomalies, the causes of GIT perforation, procedure done, mortality and morbidity, and hospital stay period. Leak from intestinal anastomosis secondary to resection as surgical interference of all our study cases or disruption excluded from the study.

The diagnosis was made mainly on clinical and radiological grounds using traditional plain X-rays (erect), U/S of the abdomen was done. Laboratory tests were done as required. However, in few cases the exact diagnosis was only achieved after operation. Prenatal diagnosis was made in 4 cases reported by U/S.

All patients were resuscitated first, given IV fluid, antibiotics (Ampicilline 100mg/kg, Garamycine 5 mg/kg, and Flagyl 20-50 mg/kg). Vitamin K, NG tube was applied. All of patients required surgical intervention. TPN was only used in few cases because of unavailability during the time of the study. Before abdominal closure, thorough irrigation of the whole cavity of abdomen using normal saline solution was done. The biopsy of the colon wall nearby the perforation was taken in all patients. The histopathological changes found to be non-specific; hemorrhage, oedema, inflammation, and necrosis were present. Bacteria or micro thrombi were not present in any biopsy specimen. All of the biopsy specimens taken from the colonic wall adjacent and distal to the perforation ganglion cells were present in all patients.

### RESULTS

The age at presentation varied between 12 hours to 27 days with a median age of the patients 3.5 days. The weight of the patients varied between 1.0 to 4.5 kg with a mean weight of 2.93 kg. The gestational age ranged between 30-42 weeks (19 were premature, 2 were post term, and 29 at term). The mean gestation age was 34 weeks. The duration of symptoms was presented to our unit varied widely between 6-72 hours, but the majority had the symptoms before 30 hours.

Table (1) shows the distribution of study sample according to age per week, gender and demonstrates that, most of the sample are within the 1<sup>st</sup> week representing 86.0%. The males are representing 76.0% while the females are 24.0% with a ratio about of (3:1).

Table (1): Age per week, number, and sex of the study sample.

Age	Gender		Total
	Males No. (%)	Females No. (%)	
1 <sup>st</sup> week	34(68.0%)	9 (18.0%)	43(86.0%)
2 <sup>nd</sup> week	3(6.0%)	1(2.0%)	4(8.0%)
3 <sup>rd</sup> week	1(2.0%)	1(2.0%)	2(4.0%)
4 <sup>th</sup> week	0 (0.0%)	1(2.0%)	1(2.0%)
Total	38 (76.0%)	12 (24.0%)	50 (100.0%)

Figure (1) presents the percentages of GIP and illustrates that 56.0% of the perforation occur in the small bowel and only 4.0% in appendix. The large bowel represents 28.0% and the stomach 12.0%.

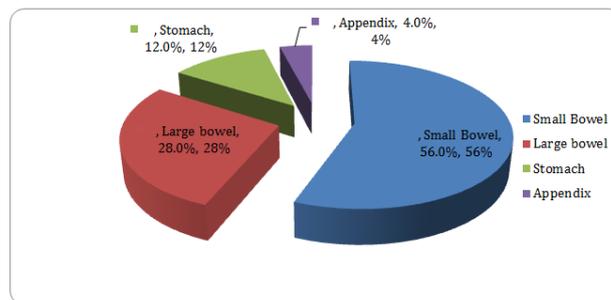


Figure (1): The percentages of GIP.

Table (2) illustrates the distribution of study sample according to clinical pictures and shows that, the hyperthermia presents in 44.0%, hypothermia in 24.0%, and normal temperature in 32.0%. During rectal examination, 52.0% found empty, 24.0% normal, and only 16.0% is bloody. Vomiting presents in 52% patients, 44.0% of them are bilious. Tachycardia present in 74.0% of the total patients. Constipation, abdominal distension, abdominal mass, scrotal swelling, and shock found in 52.0%, 42.0%, 6.0%, 12.0%, and 8.0% respectively.

Table (2): The distribution of the study sample according to Clinical pictures.

Signs and symptoms	Results	No. of patients	Total
Temperature	Normal	16 (32.0%)	50 (100.0%)
	Hypothermia	12 (24.0%)	
	Hyperthermia	22 (44.0%)	
Digital rectal examination	Normal	12 (24.0%)	50 (100.0%)
	Empty	28 (56.0%)	
	Bloody	8 (16.0%)	
Vomiting	Bilious	22 (44.0%)	26 (52.0%)
	Non-Bilious	4 (8.0%)	
Pulse rate	Normal	13 (26.0%)	50 (100.0%)
	Tachycardia	37 (74.0%)	
Constipation		26	26 (52.0%)
Abdominal distension		21	21 (42.0%)
Abdominal mass		3	3 (6.0%)
Scrotal swelling		6	6 (12.0%)
Shock		4	4 (8.0%)

Table (3) displays the results of laboratory tests among the study sample and reveals that, the WBCs results are normal in 64.0%, while the increase and the decrease in the count each represents 18.0%. Blood urea is elevated in only 12.0%, while anemia found in 30.0% of the sample. Regarding the U/S, fluid collection presents in 32.0% in comparison with 6.0% presents as mass. The positive findings of abdominal X-Ray are found in 80.0% of patients.

Table (3): The results of laboratory Investigations.

Laboratory tests	Results	No. (%)
WBCs	Normal	32 (64.0%)
	Increase	9 (18.0%)
	Decrease	9 (18.0%)
Blood Urea	Normal	44 (88.0%)
	Elevated	6 (12.0%)
Hb%	Normal	35 (70.0%)
	Anemic	15 (30.0%)
U/S	Fluid collection	16 (32.0%)
	Mass	3(6.0%)
Abdominal X-Ray		40 (80.0%)

Figure (2) demonstrates the types of delivery and shows that 64.0% of study sample are born with normal vaginal delivery and 36.0% of them having caesarian section.

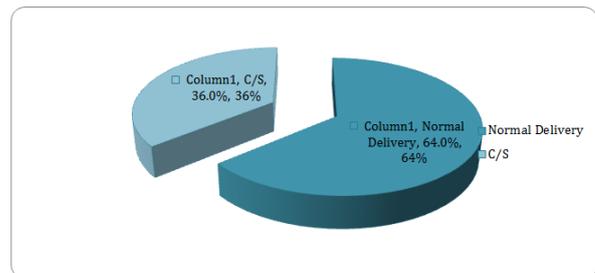


Figure (2): The types of delivery.

Table (4) demonstrates the proportions of neonatal GIP causes among the study sample and reveals that the ileum is the main site in (36.0%) of the patients; NEC is the cause in 6 out of 18 patients, Atrasia 4, meconium ileus 3, iatrogenic 3, obstructed inguinal hernia 2 patients. In Jejunum, 4 cases due to NEC, 4 Atrasia, volvulus in one patient, and meconium ileus in another. Colonic perforation is the next location representing 18.0%, 5 out of 9 are due to segmental dilatation, 2 iatrogenic, 2HD. The HD is the only cause for the perforation in appendix and cecum. Iatrogenic and biopsy are the only causes for rectal perforation. of them 1 in stomach. Two out of 4 cases in stomach perforation is due to NG tube with aggressive resuscitation, one due to NEC, and the other due to congenital absence of gastric muscle. Pyloric perforation is due to dissection of idiopathic hypertrophic pyloric stenosis within operation and represents 4.0% of all deaths.

Table (4): Causes of the neonatal GIP among the study sample.

Organ	Causes of perforation	No. of each	Total No. (%)	
Stomach	Congenital absence of gastric muscle	1	4(8.0%)	
	NEC	1		
	NG tube with aggressive resuscitation	2		
Pylorus	Due to dissection of HIPS within operation	2	2(4.0%)	
Jejunum	Atrasia	4	10 (20.0%)	
	NEC	4		
	Volvulus	1		
	Meconium ileus	1		
Ileum	Atrasia	4	18(36.0 %)	
	Meconium ileus	3		
	NEC	6		
	Iatrogenic	3		
	Obstructed inguinal hernia	2		
Appendix	Hirschsprung disease	2	2(4.0%)	
Cecum	Hieschsprung disease	3	3(6.0%)	
Colon	Ascending colon	Segmental dilatation	1	9(18.0 %)
		Hirschsprung disease	2	
	Transverse colon	Segmental dilatation	3	
	Sigmoid colon	Iatrogenic	2	
Segmental dilatation		1		
Rectum	Iatrogenic and rectal biopsy	2	2(4.0%)	
Total		50	50(100.0%)	

Figure (3) illustrates the presence of multiple perforations and shows that, the meconium ileus is the only cause of intra-uterine multiple perforations occurring in 4 patients. The extra-uterine multiple perforations are appear to be due to NEC in 5 patients and Atrasia in 2.

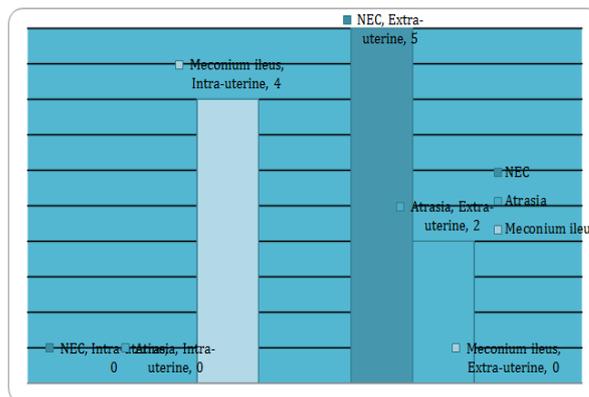


Figure (3): The percentage of multiple perforations.

Table (5) describes the mortality rates with causes of death in GIP and reveals that, the 40.0% of patients are died. The most common site for the pathology is the ileum, which found in 8 patients representing 40.0% of all deaths. Next are the Jejunum and colon, which representing 20.0% for each pathology. The stomach pathology found in 10.0%, as well as, the cecum 10.0%.

Table (5): Mortality rates with causes of death in GIP.

Pathology	Death No. (%)	Causes	Death percentages from the all
Stomach	2 (10.0%)	Late diagnosis, sepsis, and prematurity.	4.0%
Pylorus	0 (0.0%)		0.0%
Jejunum	4 (20.0%)	Sepsis, prematurity, absence of certain drugs as pancreatic enzyme.	8.0%
Ileum	8 (40.0%)	Multiple congenital anomalies, sepsis, electrolytes disturbance, deficient of pancreatic enzyme lipase.	16.0%
Appendix	0 (0.0%)		0.0%
Cecum	2 (10.0%)	Multiple congenital anomalies, sepsis, prematurity.	4.0%
Colon	4 (20.0%)	Prematurity, sepsis, electrolytes disturbance, Multiple congenital anomalies.	8.0%
Rectum	0 (0.0%)		0.0%
Total	20 (100.0%)		40.0%

## DISCUSSION

Neonatal intestinal perforation is an urgent condition and life threatening if the access to care delayed. As recognized, access to appropriate surgical care is still a enormous challenge in developing states as often are postponed before the level of care accomplished particularly in our country.

The age at presentation varied between 12 hours to 27 days with median of the patients' age 3.5 days with a mean weight of 2.93 kg and the mean gestation age was 34 weeks. The majority had the symptoms before 30 hours. Similarly, a retrospective assessment including 16 neonates with GIP done by Hyginus *et al.*,<sup>2</sup> that extended for 3 year found that the weights at presentation were varied from 0.9 to 4.7kg (having a median of 2.6kg), five infants of them were premature. Moreover, Abo-Halawa *et al.*,<sup>17</sup> found in his work that the average age at time of diagnosis was  $15.8 \pm 7.0$  days, with a range of 3–28 days. The birth weights of patients were ranged from 1500 to 3600 g. Gestational age of patients ranged from 30 to 40 weeks with an average of  $36.03 \pm 2.736$  and the presentation—surgical intervention interval was 1–6 days ( $2.0 \pm 1.1$ ). The predominance of males was clear in the current research and corresponding to findings of other works<sup>18,19</sup>, although the results of another research<sup>17</sup> showed increase in female percentage 15 (44.1%), the males still higher 19 (55.9%).

The site of perforation showed a discrepancy from the esophagus extending to the colon, and the most frequent site in the present study was small intestine which corresponding to the pediatric literature, in which, the frequent site of GIP was the small bowels, and the distal ileum was the predominant<sup>20-22</sup>. A retrospective cohort of Prgomet *et al.*,<sup>16</sup> in contrarily, reported that the commonest site of GIP was large intestine representing (45.7%), whereas the perforation of small bowel was documented in about 37.1% of study's cases. Although colonic perforation was considered as an uncommon result; however, in a latest research, Sakellaris *et al.*,<sup>23</sup> reported the colonic perforation in 18.5% of neonates. According to review of literatures, newborns with high birth weight (> 2500 g) were highly associated with colon perforation, which prevailed in our study's sample (65.7%)<sup>24</sup>. At time of the surgery, another study<sup>2</sup> found that the ileum was the widespread place of perforation (n=12/ 16). Other sites were included stomach (n=4) and colon (n=4). Colonic perforations were all linked to terminal ileal perforations in neonates with NEC. The only isolated site for colonic perforation was the cecum which noticed in neonate with Ladd's band tethering, as well as, occluding the ascending

segment of colon, which is associated with more than 50% mortality in high-risk patients<sup>25</sup>. Colonic perforation may be caused by various conditions such as necrotising enterocolitis (NEC), Hirschsprung's disease (HD), mechanical obstructions (anorectal malformation [ARM], colonic atresia), meconium plug syndrome, small left colon syndrome, idiopathic perforations, isolated intestinal perforation, stercoral perforations and rarely cystic fibrosis.<sup>4</sup>

Contrary to the common sites of CP (proximal colon and appendix) mentioned in literature, the transverse colonic segment was the frequent location of perforation in the current series. Other studies<sup>26,27</sup> showed parallel outcomes.

Furthermore, amongst the 3,401 GIP patients who attending to the NICU of Mokdong Hospital in Ewha Womans University<sup>19</sup> within 20 years time interval (extending from January 1994 till December 2013), 21 patients were included for analysis and 127 patients who died in 48 hours of birth or were referred to other hospitals were excluded, 21 preterm who showed pneumoperitoneum experienced exploratory laparotomy; 16 cases of bowel perforations (0.470%), 11 patients of small bowel, five patients of stomach (0.147%), three patients of colon, one case of ileo-cecal valve, and one appendix case. Other study of Gupta 2011<sup>28</sup>, found that the most frequent location of perforation was distal ileum followed in descending order by appendix, jejunum and cecum, with a single perforation was noted in 60 cases, while multiple intestinal perforations were present in seven patients.

The frequent presenting symptoms were constipation 52.0%, abdominal distension 42.0%, vomiting presents in 56.0% mostly bilious. Rectal examination was normal in 52.0% and bloody in only 16.0%. Hyperthermia presents in 44.0% and Tachycardia present in 74.0% of the total patients.

Abdominal distension was found in all cases, while bile-stained vomiting as reported in 11 out of 16 cases (68.8%) in the bowel perforation group. Diarrhea, gastrointestinal bleeding, and abdominal wall discoloration were also demonstrated<sup>19</sup>. These features were presented in most of the cases in several studies<sup>29,30</sup>. The etiologies, as well as, pathogenesis of GIP in neonates were expected to differ depending on the perforation's site. In the present work, the main site of perforation was the ileum in 18 patients out of 50 patients representing 36.0%, 6 patients out of those 18, were due to NEC. Worldwide, NEC is the foremost cause of neonatal GIP over other reasons like mechanical obstruction and SIP<sup>31</sup>. As the survival of premature and critical ill neonates increase, the incidence of NEC is expectedly rising. Up to 90.0% of NEC occurs in pre-terms<sup>32</sup>.

Intestinal perforation takes place in about 20.0% of those neonates who acquired NEC and the perforation is often multiple<sup>33</sup>. NEC was the key cause of perforation (33.0%) and the terminal ileum was the most frequent location. Most (56.0%) were treated by excision and primary repair of perforations. Sepsis was the leading complication (44.0%) and chief reason of mortality (72.0%). Death rate was highest (56.0%) in perforations due to further primary pathology followed by NEC (53.0%). Overall death rate was 46.0%<sup>18</sup>.

In the current series, the death rate was less in the large bowel perforation than the small bowel that had bad prognosis, and this is analogous to the findings of other studies<sup>2,17,34,35</sup>. This finding can correlate with treatment's line as the prognosis is enhanced in newborns who underwent colostomy rather than other line of treatment particularly ileostomy and resection with anastomosis. This can be clarified by the fact that colostomy diminishes the instance of surgery, and early postoperative feeding which is vital in our institutes due to lack of availability of total parental nutrition.

The mortality from neonatal intestinal perforation remains high, ranging from 40.0-70.0%<sup>1,36,37</sup>, in spite of that, a little current works have however, documented decreased rates of between 30.0-36.0%. The persistent high mortality regardless of advancements in the anesthesia technique and neonatal intensive care could be due to increasing survival of extreme premature newborns. Contrasting to NEC which linked to the elevated fraction of neonatal GIP, the Spontaneous intestinal perforation is rare and has a better prediction<sup>38</sup>. While in another study<sup>39</sup> done between 1990 and 1999, 14 neonates with intestinal perforation were treated and followed at the Ahmadu Bello University Teaching Hospital, Zaria, Nigeria. Overall, eight (59.0%) died, five with colorectal perforation and three with small bowel perforation. Moreover, in Abo-Halawa *et al.*,<sup>17</sup> the total mortality rate in general was 11 cases (32.4%). The most important risks of death were NEC (6 cases), jejunoileal atresia (2 cases), ARM (1 case), rectal injury (1 case), and meconium peritonitis (1 case).

The late arrival of neonates to the pediatric surgical department is a very concerning event. The bulk of our patients arrive in a severely harmed state. This delay could be due to incorrect initial diagnosis or delayed first contact to hospital. These late presenters have a raised rate of morbidity and death.

## CONCLUSIONS

1. A commonest perforation site is small bowel.
2. History, clinical picture, and erect abdominal X-ray are very important for the diagnosis.
3. The subsequent risk factors raise the mortality rate:
  - The pre-existing underlying diseases.
  - Malnutrition.
  - The fundamental cause of bowel perforation's nature.
  - The appearance of complications.
  - Lack of certain drugs.
  - Delay diagnosis.
  - Prematurely.
  - Associated anomalies.
4. The outcome is improved with early identification, diagnosis, and treatment.

## RECOMMENDATIONS

1. Further studies about the modifiable risk factors of neonatal bowel perforation are necessary to carry out to reduce the incidence.
2. Health education courses for the doctors about the suspected features of the perforation to ensure the early diagnosis and subsequent management.
3. Arrangement of comprehensive and well-organized referral system.

## Ethical Issues

The present study was approved by the Medical Research Ethical Committee, College of Medicine, University of Mosul. Additionally, written informed consent was obtained from all patients before the examination.

## Acknowledgement

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