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Clinico-Aetiological Spectrum of Neonates Presenting with Pneumoperitoneum: A Case Series

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Abstract: ***Neonatal pneumoperitoneum, the presence of free air in the peritoneal cavity, signifies a critical surgical emergency with a spectrum of underlying aetiologies and clinical presentations. This case series of 5 neonates talks about our institutional experience with neonates diagnosed with pneumoperitoneum, aiming to delineate the clinical characteristics, etiological spectrum, diagnostic pathways utilizing radiographic protocol within your, management strategies, and outcomes. We analyzed data of 5 neonates presenting with pneumoperitoneum between. Our findings reveal a diverse range of primary causes, including e. g., necrotizing enterocolitis, bowel perforation, congenital anomalies. The utility of the radiographs of abdomen in the timely diagnosis and identification of pneumoperitoneum and its potential associated findings will be highlighted. Furthermore, we will discuss the varied surgical and non - surgical management approaches employed and their correlation with patient outcomes, including morbidity and mortality. This study underscores the importance of a high index of suspicion and a systematic diagnostic and management algorithm for neonates presenting with this life - threatening condition. Methods: Five neonates presenting with spontaneous bowel perforation were analyzed with respect to clinical presentation, management and outcome. Results: Out of 5 neonates, 3 (60%) were very low birth weight, 1 (20%) was low birth weight.4 (80%) out of 5 neonates were low birth weight, only 1 had birth weight above 2.5kg. [6] out of 5 neonates, 2 (40%) were very preterm (28 to less than 32 weeks), 2 (40%) were moderate to late preterm (32 to 37 weeks). Only 1 (20%) neonate was born full term. Out of 5 neonates, 2 (40%) developed symptoms within 72 hours of birth, 2 (40%) presented after 72 hours till 1 week. Only 1 neonate presented after 1 week of life. All the neonates in the series had Abdominal distension as the primary complaint (100%). Other symptoms noticed were blood in stools in 1 of them, while other neonate also had history of not passed meconium since birth.4 (80%) out of 5 neonates had systemic haemodynamic disturbances in the form of shock, hypoglycemia 1 (20%), hyponatremia 2 (40%), metabolic acidosis 2 (40%), convulsions 1 (20%), Respiratory failure 1 (20%). Among the post - operative complications, sepsis was the commonest in 4 (80%) neonates, followed by surgical site infection 1 (20%), enterocutaneous fistula 1 (20%) and DIC 1 (20%). Out of 5, 4 neonates could not survive due to the prematurity and sepsis related complications. Conclusions: Neonatal pneumoperitoneum remains a surgical emergency and outcome can be lethal if the problem is not addressed early. Given the alarmingly high mortality rate of approximately 80% in pneumoperitoneum, coupled with the prevalence of significant complications, the findings underscore a critical need for comprehensive re - evaluation and targeted interventions.***

Keywords: Pneumoperitoneum, Perforation, Spontaneous, Neonatal, NEC, laparotomy, peritoneal drainage

Abbreviations: Spontaneous Intestinal Perforation (SIP), Necrotising Enterocolitis (NEC), Gastro - intestinal tract (GIT), umbilical arterial catheter (UAC), patent ductus arteriosus (PDA), Pregnancy Induced Hypertension (PIH), preterm premature rupture of membrane (pPROM), patent ductus arteriosus (PDA), Disseminated Intravascular Coagulation (DIC).

1. Introduction

Pneumoperitoneum is an alerting finding to physicians that is almost attributed to a perforation along the gastro - intestinal tract (GIT). Neonatal gastrointestinal perforation is a common condition carrying a mortality of 17–60%. [1] Clinical suspicion is supported by radiological signs, which may be subtle and must be sought specifically. Despite improvements in anaesthesia and neonatal intensive care, mortality has remained high, especially in the preterms. [2] Many causes have been identified for same like Necrotising Enterocolitis (NEC), Spontaneous intestinal perforation (SIP) etc. Spontaneous intestinal perforation in the newborn is defined as a single bowel wall perforation typically occurring in the terminal ileum. It is a life - threatening condition that affects very low birth weight infants (birth weight of less than 1500 g) and extremely low birth weight (birth weight of less than 1000 g) infants. [1, 2, 3, 4] The exact pathophysiology of spontaneous intestinal perforation is a subject of debate. Prematurity and low birth weight are significant risk factors. The etiology and pathogenesis of the disease is unknown and multiple theories have been proposed, but, none has been proven. Conditions associated with fetal or neonatal hypoxia are important antecedents for this emerging distinct entity [1] SIP is thought to be secondary to ischemia [9, 10] and involves a deficiency of muscularis propria in about a quarter of cases [11]. SIP often occurs in the terminal ileum, a watershed region prone to local ischemia that can be compounded by regional intestinal ischemia, secondary to hypotension, the presence of an umbilical arterial catheter (UAC), patent ductus arteriosus (PDA) and birth asphyxia

2. Materials and Methods

Five neonates presenting with acute abdomen at the Neonatal Intensive Care unit (NICU) at a tertiary care centre in western Maharashtra as a result of spontaneous bowel perforation were analysed with respect to clinical presentation, radiographic features, management and outcome in prospective type of study over 6 months. All patients had complete blood count, C - reactive protein level, renal/liver function test and arterial blood gases. Resuscitation with intravenous fluids and parenteral antibiotics was done for all cases. Further management was tailored for each case according to the possible cause, general condition and individual circumstances.

Case Report - 1

A very low birth weight (1.18kg) newborn female child born to 26 years old primigravida mother having history of Pregnancy Induced Hypertension (PIH), preterm premature rupture of membrane (pPROM) for 17 hours, mother received only one steroid dose before delivery. Baby was born at 31 weeks + 5 days period of gestation by vaginal delivery, baby cried immediately after birth. On admission baby had respiratory distress, empirically started on injection Taxim and Amikacin. On 3rd day of life baby had tachycardia and machinery Murmur, with hyperdyanamic circulation, considering Patent Ductus Arteriousus clinically, started on injection paracetamol, continued for 5 days. Later on baby developed signs of septic shock, required ionotropes and antibiotics graded up after taking blood culture. Baby needed ventilator support in view of Refractory septic shock. Slowly descelated ionotropes and ventilator settings as the perfusion was improving and then extubated Blood culture was suggestive of E. Coli sepsis. Minimal enteral feeds was started, but baby developed abdominal distension, with history of not passed stools since 3days also noticed tachypnoea and acidotic breathing. Kept nil per oral and routine investigations sent suggestive of thrombocytopenia, low sodium level and ABG suggestive of metabolic acidosis. Gradually the abdominal distension was increasing serial erect abdominal xrays done, suggestive of air under diaphragm suggestive of pneumoperitoneum. Considering Necrotising Enterocolitis grade 3b Surgeons planned glove drain. Though Surgery was planned, but Baby developed DIC, expired.

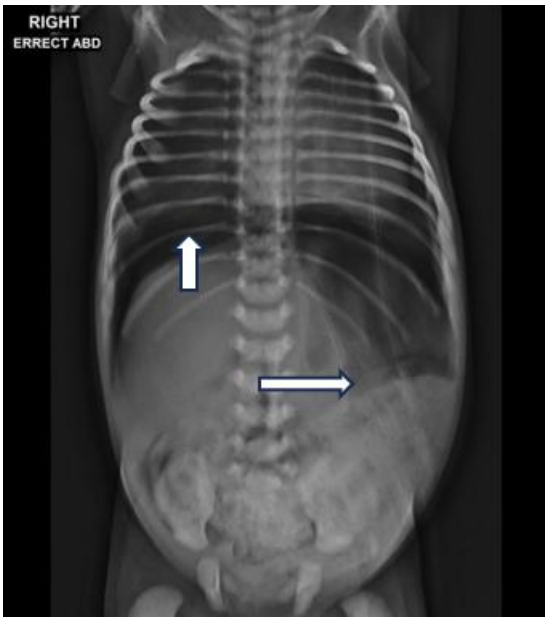

Figure 1: Erect Abdominal Radiograph showing signs of pneumoperitoneum: dilated bowel loops (left horizontal arrow), subdiaphragmatic free air (Right upper arrow)

Case Report - 2

A newborn male child born to 20 years old primigravida mother with history of PIH by vaginal delivery at 32 weeks period of gestation with birth weight of 1.1 kg. Baby cried immediately after birth. Started on empirical antibiotics Cefotaxim and Amikacin. At 7 hours of life baby started getting abdominal distension, erect abdominal radiograph was done which was suggestive of pneumoperitoneum, gastric decompression done and kept nil per oral. Paediatric surgeon put glove drain which led to passage of sudden gush of air. Serial erect abdomen xrays done suggestive of air under diaphragm, multiple air fluid levels suggestive of intestinal obstruction with perforation. Simultaneously, Baby had deranged perfusion, fluid resuscitation was followed by injection dopamine septic screen sent, antibiotics graded up. After the baby was hemodynamically stable, baby was taken for Surgery, intraoperative findings were suggestive of 2×2 jejunal perforation with multiple serosal tears all over the jejunal and ileal parts, jejuno - jejunal end to side anastomosis was done. Post operatively, baby was in hypovolemic shock, red cell transfusion was given, added ionotropes but baby succumbed to death due to DIC.

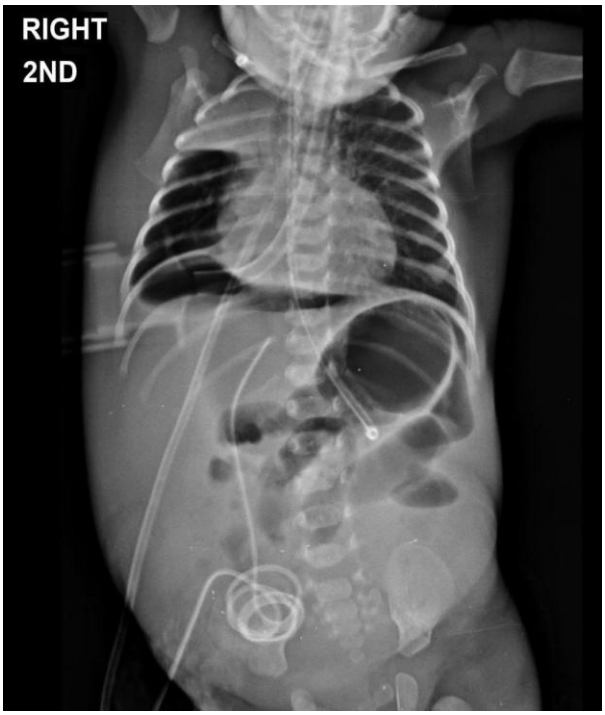

Figure 2: Erect Radiograph of Abdomen Showing Free Subdiaphragmatic Air, Multiple Air Fluid Levels

Case Report 3

A newborn 36 hours old male child referred from private hospital in view of prematurity (34 weeks plus 6 days) and very low birth weight (1.32 kg) born to G3P1L1A1 mother with no antenatal risk factors by vaginal delivery. Baby cried immediately after birth, had respiratory distress was kept on bubble CPAP, Antibiotics were started as per unit policy after taking blood culture. On admission perfusion was deranged hence added ionotropes, septic screen was sent, baby had one episode of convulsion in the form of left Upper limb tonic convulsions and uprolling of eyeballs, blood sugar was normal, due to increased respiratory distress mechanical ventilation was started. CBC was suggestive of thrombocytopenia, hence antibiotics graded up, added ionotropes, diagnosed with early onset probable sepsis. Baby had repeated episodes of hypoglycemia hence started on glucose infusion. Had one episode of blood in stool with abdominal distension in 2nd week of life. Erect abdominal radiograph was done suggestive of air under diaphragm, surgeons planned a bilateral glove and drain as baby was not hemodynamically stable. But Baby succumbed to death due to Refractory septic shock on day 2 of the procedure.

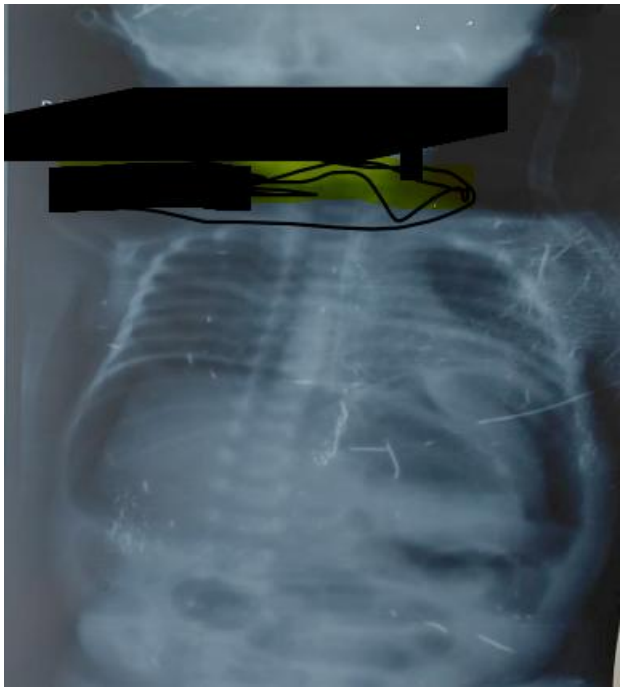

Figure 3: Erect Radiograph of Abdomen Showing Free Subdiaphragmatic Air, Multiple Air Fluid Levels

Case Report - 4

3 days old male child born to 23 years primigravida mother at term gestation (38 weeks) by normal vaginal delivery. Baby cried immediately after birth and breast feeding started in half an hour of birth and given for 2days, referred in view of abdominal distension since 1 day and not passed stools since birth. On examination abdominal distension present, bowel sounds absent gastric tube aspirate were greenish in colour. With increasing distension, Respiratory distress was present, erect abdomen Radiograph was done suggestive of pneumoperitoneum. Surgery opinion was sought, glove drain was put. After 2 days, Baby was taken for Surgery, intraoperative findings were suggestive of breach in the continuity 10 cm proximal to ileum. Operated for the same. Next day due to septic shock baby succumbed to death.

Figure 3: Erect Radiograph of Abdomen Showing Free Subdiaphragmatic Air, Multiple Air Fluid Levels

Case Report 5

A newborn male born to 21 years plL1A1 mother with no significant antenatal history at 34+6 weeks with birth weight 1.77 kg, by vaginal delivery. Baby cried immediately after birth. No significant history to mother. On general physical examination baby had some congenital anomalies like Bilateral preauricular sinus, Wide spaced nipples, Hydrocele. Penis embedded in it, Bilateral undescended testis (felt in inguinal region). On 2nd day of life abdominal distension was noted and erect abdomen radiographs was done, showed pneumoperitoneum. Suspected spontaneous intestinal perforation, surgeons advised to put glove and drain. Abdominal distension gradually reduced for few days, following which, there was persistent greenish discharge from the glove drain site from 8th day of life and hence planned surgery ileostomy was done. Post procedure child was in shock required inotropes and upgradation of antibiotics and required ventilation. Platelet count was persistently low, required platelet transfusion and red cell transfusion for dropping haemoglobin. Had repeated episodes of hypoglycaemia required Glucose infusion. Platelet count was persistently low, child was in Disseminated Intravascular Coagulation (DIC), died on 22nd day of life.

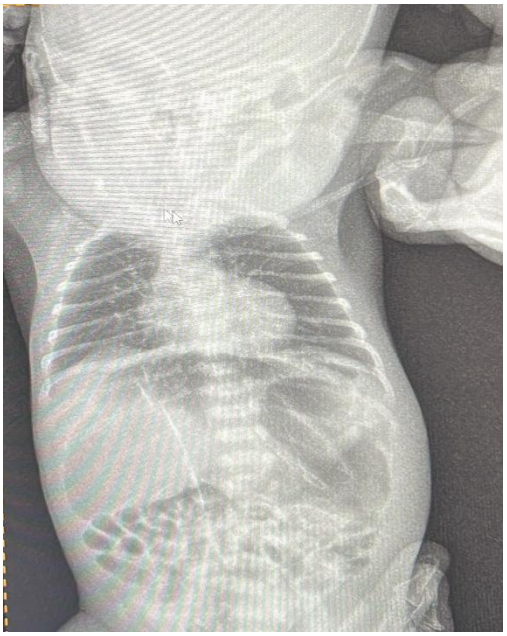

Figure 5: Erect Radiograph of Abdomen Showing Free Subdiaphragmatic Air, Multiple Air Fluid Levels

Table 1: Showing summary of cases

Case no.	1	2	3
Antenatal risk factor	Severe PIH, Pprom	PIH	None
Gestational age at birth (weeks)	31+5	32	34+6
Birth weight (kg)	1.18	1.1	1.32
Sex	Female	Male	Male
Age of presentation	Day 7	7 hours of life	2 weeks of life
Clinical features	Abdominal distension	Abdominal distension	Blood in stools, Abdominal distension
Systemic complications	metabolic acidosis, shock hyponatremia	Septic shock	Shock, hypoglycemia, hyponatremia metabolic acidosis convulsions
Xray features	Pneumatosis intestinalis Pneumoperitoneum	Pneumoperitoneum	Pneumoperitoneum
Aetiology of perforation	NEC grade 3b, PDA	?Spontaneous Intestinal perforation	NEC 3b
Site of perforation	? small intestinal	1 jejeunal perforation	Not known
Glove drain	Done	Done	Done
Exploratory lapratomy	Not done	Done	Not done
Post - operative complications	Surgical site infection, sepsis	DIC, sepsis	-
Other associated congenital anomalies	None	None	None
Outcome	death	Death	Death

4	None	38	2.5	Male	Day 4	Abdominal distension, not passed stools since birth	None	Pneumoperitoneum	?Spontaneous Intestinal perforation	Jejunal perforation	Done	Done	sepsis	None	Discharged
5	None	34+6	1.77	Male	Day 2	Abdominal distension	Shock, respiratory failure	pneumoperitoneum	?Spontaneous Intestinal perforation	Distal ileum	Done	Done, Ileostomy	Enterocutaneous fistula Sepsis	1. Bilateral preauricular sinus 2. Congenital hydrocele 3. Bilateral undescended testis	Death on day 22 of life

3. Results

Out of the 5 neonates studied, 4 (80%) were females and only 1 (20%) was male. Out of 5 neonates studied, 2 neonates had a significant antenatal history. Both of them had Pregnancy induced hypertension, while 1 of them also had preterm prolonged rupture of membranes, which is one of the risk factor for early onset of sepsis.

Out of 5 neonates, 3 (60%) were very low birth weight, 1 (20%) was low birth weight.4 (80%) out of 5 neonates were low birth weight, only 1 had birth weight above 2.5kg. [6] out of 5 neonates, 2 (40%) were very preterm (28 to less than 32 weeks), 2 (40%) were moderate to late preterm (32 to 37 weeks). Only 1 (20%) neonate was born full term. [7]

Out of 5 neonates, 2 (40%) developed symptoms within 72 hours of birth, 2 (40%) presented after 72 hours till 1 week. Only 1 neonate presented after 1 week of life. All the neonates in the series had Abdominal distension as the primary complaint (100%). Other symptoms noticed were blood in stools in 1 of them, while other neonate also had history of not passed meconium since birth.4 (80%) out of 5 neonates had systemic haemodynamic disturbances in the form of shock, hypoglycemia 1 (20%), hyponatremia 2 (40%), metabolic acidosis 2 (40%), convulsions 1 (20%), Respiratory failure 1 (20%).

All 5 neonates had a typical picture of pneumoperitoneum on erect abdominal radiographs AP view. [fig 1, 2, 3, 4, 5]. The aetiology of pneumoperitoneum in 2 (40%) out of 5 neonates, was necrotising enterocolitis owing to their prematurity and Patent ductus arteriosus, while 3 (60%) neonates were suspected to have a Spontaneous Intestinal perforation leading to pneumoperitoneum.

Out of 5 only 1 (20%) neonate had associated congenital anomalies Bilateral preauricular sinus, Congenital hydrocele, Bilateral undescended testis which points towards associated gastrointestinal anomalies leading to perforation and pneumoperitoneum.

Out of 5 neonates 2 (40%) had jejunal perforation, 1 (20%) had ileal perforation. In other 2 neonates, the site of perforation could not be ascertained as exploratory lapratomy could not be done due to haemodynamic instability. All the 5 neonates had undergone glove drain insertion prior to lapratomy. This method to relieve the pneumoperitoneum helps to drain the intraperitoneal air in haemodynamically unstable neonates, very low birth weight neonates.3 neonates underwent exploratory lapratomy, post glove drain insertion after achieving haemodynamic stability.

Among the post - operative complications, sepsis was the commonest in 4 (80%) neonates, followed by surgical site infection 1 (20%), enterocutaneous fistula 1 (20%) and DIC 1 (20%). Out of 5, 4 neonates could not survive due to the prematurity and sepsis related complications.

4. Discussion

Pneumoperitoneum in neonates is one of the major causes of mortality and morbidity. The diagnosis and management of neonatal pneumoperitoneum revolves around necrotizing enterocolitis (NEC) in most of the published literature. Although NEC remains the major cause of pneumoperitoneum in a neonate, there are several other causes leading to free air in the peritoneal cavity. A pneumoperitoneum (an abnormal collection of free air in the peritoneal cavity) is seen on an abdominal radiograph. The air can be secondary to perforation of the gastrointestinal (GI) tract (most common), from the respiratory tract, or secondary to iatrogenic causes. Necrotizing enterocolitis (NEC) with perforation is the most common cause of a pneumoperitoneum in the neonate. Gastro intestinal perforations in neonates remain a challenging surgical emergency.

In the literature the incidence of pneumoperitoneum was more common among males compared to females. Wang QY et al [8] and Deb A et al. studied idiopathic pneumoperitoneum in neonates and found that males were affected [9] more than females. This is in contrast to our case findings as in our case series, it was more common in females as compared to males.

In our study, 1 neonate developed pneumoperitoneum secondary to the Necrotising enterocolitis where mother had history of Premature rupture of membrane. Though no clear association was found, some Associated factors which may lead to are premature rupture of membranes and low Apgar. Yan Su etal studied the risk factors on NEC in neonates, found that of Premature rupture of membrane is a significant risk factor for NEC leading to perforation. [10] Pregnancy induced hypertension (PIH) may be a contributing factor as it is known to cause bowel reperfusion Injury and perforation.

3 neonates out of 5 presented within 4 days of birth, while 2 of them had a delayed presentation. The neonates presenting within 4 days had no underlying aetiology, so it was attributed to be due to Spontaneous Intestinal Perforation. In other studies age of presentation was 4.8 days for Spontaneous Intestinal Perforation [11]. While other 2 neonates had a delayed presentation ranging from 7 days to 14 days, it was due to Necrotising enterocolitis (NEC). In a systematic review by Elda Dermyshi et al mean age at presentation was around 3 weeks.

Pneumoperitoneum is a radiological diagnosis. It is mainly diagnosed by plain X - ray film. It usually shows free air under the diaphragm or in a superiorly dependent location on abdominal radiographs. [13 14]. All 5 neonates had typical features of pneumoperitoneum as mentioned above. While one of them had additional features of pneumatosis intestinalis, which is a feature of NEC.

Surgical pneumoperitoneum is mostly accompanied by fever, severe and progressive abdominal pain, and abdominal distension as well as significant peritonitis and even shock [15, 16] All the neonates in the series had Abdominal distension as the primary complaint (100%). Other symptoms noticed were blood in stools in 1 of them, while other neonate also had history of not passed meconium since birth.4 (80%) out of 5 neonates had systemic haemodynamic disturbances in the form of shock, hypoglycemia 1 (20%), hyponatremia 2 (40%), metabolic acidosis 2 (40%), convulsions 1 (20%), Respiratory failure 1 (20%). While other symptoms could be due to pneumoperitoneum, hypoglycemia, hyponatremia and metabolic acidosis could be due to NEC. [17, 18]

The highest frequency of NEC is in very low birth weight (VLBW) infants, i. e., those born weighing less than or equal to 1500 grams, ranging from 5 to 12% in most studies [19]. In our case series, both the neonates diagnosed to have NEC were very low birth weight. Among the neonates diagnosed with SIP, 2 of them were low birth weight, while one had weight above 2.5kg.

In all our cases, Peritoneal drainage by Glove drain was done in all cases. Peritoneal drainage has been evaluated in various studies, some claiming it to be useful while others found it doubtful [21]. All the cases in our series required a revision laparotomy as a definitive management. . Although peritoneal drainage was done in all 5 cases, but in none of them it proved to be helpful to avoid laparotomy. Indeed it helped to stabilise the haemodynamically unstable patient. Two randomized control trials [22, 23] have found that survival rates were not statistically different between peritoneal drainage and laparotomy groups. In our case series only one neonate survived following both procedure.

Dysmorphic features, congenital anomalies, and antenatal suspicion of gastrointestinal anomalies, all increase the probability that gastrointestinal perforation is the cause of pneumoperitoneum. [24] In one of our case of SIP, LBW and preterm, there were many congenital anomalies, which suggests an antenatal perforation.

Majority of the neonates who underwent both peritoneal drainage and laparotomy developed sepsis, which was followed by surgical site infection and enterocutaneous fistula. Which may be due to the prematurity and susceptibility to infection. Also poor pre - operative and post - operative nutrition can be a contributory factor.

The overall mortality in our study was 80% more than most studies and for but approaches 100% in infants with the most severe form of the disease. This mortality could be due to poor preoperative haemodynamic condition, prematurity, low birth weight and underlying NEC associated multiple clinical conditions.

5. Conclusion

Neonatal pneumoperitoneum remains a surgical emergency and outcome can be lethal if the problem is not addressed early. Given the alarmingly high mortality rate of approximately 80% in pneumoperitoneum, coupled with the prevalence of significant complications, the findings underscore a critical need for comprehensive re - evaluation and targeted interventions. This data strongly suggests that the current management protocols may be inadequate for this specific patient population within the unit. Further investigation into the underlying causes contributing to this elevated mortality and complication rate is paramount. This should include a thorough analysis of patient demographics, disease severity upon admission, diagnostic and therapeutic approaches, infection control measures, and resource availability. Ultimately, the insights gained from this analysis must inform the development and implementation of evidence - based strategies aimed at significantly improving patient outcomes and reducing the burden of mortality and morbidity in neonates developing pneumoperitoneum.

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Conflict of Interest - None

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