

NEONATAL PERITONITIS*

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SUMMARY: Zorludemir Ü, Koca M, Olcay I, Yücesan S. (Department of Pediatric Surgery, Çukurova University Faculty of Medicine, Adana, Turkey). Neonatal peritonitis. Turk J Pediatr 34: 157-166, 1992.

A retrospective study was undertaken over an eight-year period to assess the mortality rate of 66 newborns who had undergone surgery in our clinic because of peritonitis. The mortality rate for the patients admitted in poor condition was 95.2 percent, whereas it was 45.5 percent for those in good condition. There was a 100 percent mortality associated with newborns that had hypothermia and with those that had severe respiratory difficulties, whereas it was 92.3 percent for low-birth-weight infants and 86.5 percent for dehydrated infants. All babies with sclerema neonatorum died. The newborns with white blood cell counts under 5,000/mm³ also did not survive (83.3%). Etiologically, congenital megacolon, meconium ileus and spontaneous gastrointestinal perforations were the most frequent anomalies leading to death (100%). In the newborns with gastrointestinal perforations, most deaths occurred in patients with perforations of the cecum, duodenum and stomach (100%). Mortality seemed to be greater in patients with complications (77.3%), and it rose to 83.3 percent for patients who had to undergo a repeat operation due to complications. The overall mortality rate was found to be 71.2 percent. *Key words: peritonitis, newborn.*

In the last decade there have been many developments in the intensive care techniques applied to the newborn, but in spite of all these improvements, peritonitis of the newborn is still one of the most frequent causes of mortality. Until Agerty et al¹ first operated on this condition in 1943, newborn peritonitis was considered to be incurable. Rickham² reported that peritonitis is the leading cause of mortality in newborns. The purpose of this study is to evaluate the mortality rate and the factors affecting mortality in a group of newborns with peritonitis.

Material and Methods

A retrospective clinical evaluation was made of 66 newborns with peritonitis hospitalized between 1977-1988 at the Çukurova University Faculty of Medicine. Peritonitis caused by ruptured omphalocele or gastroschisis is not included in this review. The diagnosis of peritonitis was arrived at from operative findings.

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Parameters and their effects on mortality were as follows: age, sex, period elapsed up to admission, general condition, body temperature, pulse rate, respiration, body weight, skin turgor and tonus, sclerema neonatorum, white blood cell count in peripheral blood, etiology, gastrointestinal perforations, complication (s), reoperation (s).

The general condition of the patient, which is one of the parameters, was classified as a) poor: patients with serious respiratory problems, sclerema neonatorum, septic shock, metabolic acidosis or severe (>10%) dehydration; b) moderate: patients with mild respiratory problems, moderate (5-10%) dehydration or decreased neonatal reflexes; c) good: patients with mild (5%) dehydration. Temperatures between 36.0° - 37.5 °C obtained by skin monitoring were defined as normothermia, those below 36.0 °C as hypothermia, and temperatures above 37.5 °C as hyperthermia.

Results

Of 66 neonates with peritonitis, 47 died (71.2%). None of the patients were admitted during the first day of life. Twenty-three of the newborns were 24-48 hours old on admission and 15 of them died (65.2%). The mortality rate of the 33 newborns in the 2-7 day age-group was found to be 72.7 percent. The 8-15 day age-group consisted of four patients, all of whom died. The 22-30 day age-group, which consisted of four newborns, had a 50 percent survival rate (Table I).

TABLE I: Mortality According to Age Group

Age of Infant	Number of Patients	Mortality Rate (%)
24-48 hours	23	15 (65%)
2-7 days	33	24 (72.7%)
8-15 days	4	4 (100%)
16-21 days	2	2 (100%)
22-30 days	4	2 (50%)
Total	66	47 (71.2%)

As regards sex, 37 (75.5%) of a total 49 male newborns and 10 (58.8%) of a total 17 female newborns did not survive.

The interval between onset of symptoms and admission ranged between 24 hours to 9 days. The number of deaths as a function of this interval was 15 out of 23 patients presenting in the first 24-48 hours (65.2%) and 32 out of 43 patients presenting after 48 hours (74.4%) (Table II).

TABLE II: Effect of Time of Admission on Mortality

<u>Interval between Onset of Symptoms and Admission</u>	<u>Number of Patients</u>	<u>Mortality</u>
24-48 hours	23	15 (65.2%)
3 days	18	16 (88.8%)
4 days	8	5 (62.5%)
5 days	2	1 (50%)
6 days	6	3 (50%)
7-9 days	9	7 (77.7%)
Total	66	47 (71.2%)

At admission, 21 of the patients (31.8%) were in poor condition, while 34 (51.5%) were in moderate and 11 (16.6%) were in good condition. In respect to their general condition, the mortality rates of the babies in poor condition were 95.2%, moderate condition 64.7% and good condition 45.5% (Table III).

TABLE III: General Condition and Mortality of 66 Newborns With Peritonitis

<u>General Condition of Patient</u>	<u>Number of Patients</u>	<u>Mortality</u>
Poor	21	20 (95.2%)
Moderate	34	22 (64.7%)
Good	11	5 (45.5%)
Total	66	47 (71.2%)

Physical findings at admission and their relation to the mortality rate can be summarized as:

- Body temperature: All of the five patients with hypothermia died at admission. Of the 52 patients with normal body temperatures, 36 (69.2%) died, while of the nine with hyperthermia, six (66.7%) died.
- Pulse rate: Nine newborns had a pulse rate below 120/min and the remainder had rates above this figure. The mortality rate was 77.7 percent in the first group of patients and 70.1 percent in the second group of patients.
- Respiration rate: Eight of the ten newborns with bradypnea (80%) and all 18 newborns with tachypnea died. With regard to the 38 newborns with a normal respiration rate, mortality was found to be 55.2 percent.

d) Body weight: Thirteen newborns weighed below 2500 g and 53 were above that weight in the study group. The mortality rate of the underweight patients was 92.3 percent (12 out of 13) and for those above 2500 g, it was 66.0 percent (35 out of 53). Of the 13 newborns with a body weight below 2500 g, eight were premature and all died.

e) Turgor and tonus: There were 52 patients with decreased turgor and tonus and 45 of them (86.5%) died. The mortality rate of the 14 patients who were normal with respect to turgor and tonus was found to be 14.2 percent (2 out of 14).

f) Sclerema neonatorum: All 20 newborns with sclerema neonatorum died. The mortality rate was 58 percent in the remaining 46 patients.

Ten of the 12 newborns with white blood cell counts below $5000/\text{mm}^3$ (83.3%), 36 of the 51 newborns with counts in the range of $5,000\text{--}15,000/\text{mm}^3$ (70.5%) and one of three newborns with a count above $15,000/\text{mm}^3$ (33.3%) died.

The etiological factors that resulted in peritonitis in our patients were grouped as follows: a) primary etiological factors (this refers to factors that cause peritonitis in patients who have not undergone surgery).

In this group, seven of 11 patients (63.6%) with an imperforate anus; seven of ten patients (70%) with intestinal atresia; all seven patients with Hirschsprung's disease; four of five patients (80%) with intrauterine gastrointestinal perforations; all four patients with meconium ileus; one of four patients (25%) with necrotizing enterocolitis (NEC); one of three patients (33.3%) with intussusception, and two patients with spontaneous gastrointestinal perforations died. b) secondary etiological factors (patients with leakage from previous intestinal anastomosis were included in this group). Primary pathologies for anastomosis were: Ileal atresia in three newborns, anal atresia in two, meconium ileus in two, and jejunal atresia in two. There was one newborn with duodenal web, one with an annular pancreas, and one with an ileal web. Ten of the 12 (83.3%) patients with anastomotic leakage died (Table IV).

Of the 66 newborns operated on, 53 (80.3%) had perforations or anastomotic leakage. In 12 of these 53 patients, peritonitis was caused by anastomotic leakage that developed after the initial operation. The location of the perforations in the remaining 41 newborns were twenty-three perforations (56%) of the colon and rectum, 14 (34.1%) of the jejunum and ileum, and four (9.7%) of the stomach and the duodenum.

Of the 53 patients with perforations and anastomotic leakage, 37 (69.8%) died. Perforations of the stomach, duodenum and cecum resulted in a fatal outcome for all of these patients. Fifteen of 23 newborns (65.2%) with perforations of the colon and 12 of 18 newborns (66.7%) with perforations at locations other than the colon also died.

Postoperative complications developed in 22 patients, and the mortality rate in this group was 77.3 percent. In the 44 newborns with no postoperative complications, the mortality rate was found to be 68.1 percent.

Twelve neonates with peritonitis had to be operated on again due to complications, and ten subsequently died (83.3%). Of the 54 patients who did not require a repeat laparotomy, 37 died (68.5%).

TABLE IV: The Relationship Between Mortality and Etiological Factors

<u>Etiology</u>	<u>Number of Patients</u>	<u>Mortality</u>
Anastomotic leakage	12	10 (83.3%)
Imperforate anus	11	7 (63.6%)
Intestinal atresia	10	7 (70%)
Congenital megacolon	7	7 (100%)
Intrauterine perforation	5	4 (80%)
Meconium ileus	4	4 (100%)
N.E.C.	4	1 (25%)
Intussusception	3	1 (33.3%)
Spontaneous GI perforation	2	2 (100%)
Birth trauma	2	— (0%)
Iatrogenic	2	— (0%)
Annular pancreas	1	1 (100%)
Primary peritonitis	1	1 (100%)
Rectosigmoid tumor	1	1 (100%)
Volvulus due to malrotation	1	1 (100%)
Total	66	47 (71.2%)

Discussion

Mortality from newborn peritonitis is high. Churchill³ reported in 1825 that six percent of all childhood deaths that occurred in Trouves Children's Hospital were due to peritonitis. Several attempts had been made to establish the mortality rate of newborn peritonitis between 1939 and 1984.

It has been found that the mortality rates for this disease vary from 33 to 99 percent (mean 67%; Table V)^{2,4-13}. In a review of 515 patients with gastrointestinal perforations, Lloyd¹⁴ found the mortality rate to be 71 percent. In a study on mortality caused by meconium peritonitis, Tibboel and Molenaar¹³ evaluated the

TABLE V: Mortality Rates Reported by Other Authors

Author	Publication Date	Number of Patients	Mortality Rate (%)
Thelander ⁴	1939	85	99
Rickham ²	1954	17	40
Cruze ⁵	1961	58	78
Fonkalsrud ⁶	1966	172	78
Birtch ⁷	1969	99	62
Cerise ⁸	1969	11	82
Singer ⁹	1972	32	66
Emanuel ¹⁰	1978	55	65
Prevot ¹¹	1979	32	68
Bell ¹²	1983	60	33
Tibboel ¹³	1984	67	67

years between 1940 and 1980, and divided them into five periods. They reported that there was no significant decrease in mortality rates, with the lowest recorded at 55 percent. Lister and Rickham¹⁵, found that 40 percent of all fatalities in the newborn surgery units are due to neonatal peritonitis. These reports obviously demonstrate that the 71.2 percent mortality rate observed in our study group correlates with other findings.

In contrast to the high incidence of one-day-old babies in previous reports, all the newborns in our study group were more than two days old. In our series, the mortality rate was found to be high in 8 to 21 day-old babies (100%), while it was significantly lower (50%) in the 22 to 30-day-old group. This difference was probably not a factor of age difference, but rather because peritonitis in the older age group was not congenital and that the interval which had elapsed between the initial signs of peritonitis and hospitalization was short. The younger group with congenital peritonitis was brought to the hospital when more than one week old, which is probably why such a long-lasting pathology contributed to the high mortality rate.

The reported sex ratio (boy/girl) in peritonitis of the newborn varies from 1/1 to 3/1^{9,12,13}. This ratio was 3/1 in our series. Bell¹² reported that the mortality rate in males was two-fold that of females. In our series, 75.5 percent of the male cases and 58.8 percent of the female cases died. Therefore, the survival rate in girls is 1.7-times more than in boys. There seems to be no explanation for this fact in the literature.

There are several studies which demonstrate that the period between the onset of symptoms of peritonitis and the initiation of treatment affects mortality. Tibboel and Molenaar¹³ reported that in newborns, for which this period is less than 48 hours, the mortality rate was 48 percent, and that this rate increases up to 91 percent for the remainder of cases. In a series of 99 patients, Birch et al⁷ reported that for 50 patients whose hospital admission occurred in less than 24 hours, the mortality rate was 51 percent; for those admitted between 24 and 48 hours it was 71.5 percent, and for the patients admitted after 48 hours this rate increased to 80 percent. In the same study, it was also reported that the survival rate increased 2.5-times if the patients were operated on within the first 24 hours. Bell¹² found that the mean interval between onset of symptoms and admission in surviving newborns with peritonitis was 19 hours, whereas it was several hours for fatal cases. In a study of 11 patients conducted by Cerise and Whitehead⁸, the two babies that survived were admitted after 48 hours. In our series, as we have already mentioned, no patient was admitted to our clinic in the first 24 hours of life. As for the patients who were admitted between 24 and 48 hours, mortality was 65 percent and for those who were hospitalized after 48 hours, it was 74.4 percent. In our study, the mean admission period for survivors was 32 hours and for fatal cases, 80 hours.

Body temperature also affects mortality in newborns. Some reports support the view that hypothermia increases mortality^{6,9}. In our series, the mortality rate was 100 percent in hypothermic patients, whereas it was 66.6 percent in the others. Normally, inflammatory pathologies cause an increase in body temperature. If the patient's resistance is low, the body temperature does not increase. Therefore, body temperature of the newborn is inversely proportional to mortality.

Bradycardia is seen in severe cases of neonatal peritonitis, and generally results in death^{6,9,12,15}. In our study group, the mortality rate was 77.8 percent in the babies with pulse rates below 120/min, and 70 percent in babies with pulse rates above 120/min. Reports in the literature confirm our findings which support the view that bradycardia is more serious than tachycardia in newborns with peritonitis.

Respiratory difficulties, which are seen in almost half of the patients, also affect mortality in newborn peritonitis^{6,8,9,15}. Birch et al⁷ calculated a mortality rate of 87 percent in patients with respiratory difficulties, and a mortality rate of 49 percent in other patients. In our series, eight of ten newborns (80%) with bradypnea and 18 with tachypnea all died, whereas in 38 patients with no respiratory problems, the mortality rate was 55.2 percent. These findings indicate that respiratory difficulties increase mortality two-fold. In other words, respiratory difficulties become more serious when peritonitis is severe.

There is a close correlation between body weight and mortality in neonatal peritonitis. Fonkalsrud et al⁶ reported a mortality rate of 90 percent in a group of

172 newborns who weighed less than 2500 g and 72 percent for the others. Singer and Hammar⁹ studied 32 patients and reported a mortality rate of 90 percent in the babies under 2500 g, and 42 percent in the babies exceeding 2500 g. Birtch et al⁷ showed that in a study comprising 99 patients, the mortality rate was 71 percent in the infants under 2000 g, 53 percent in the infants between 2000-3500 g and 70 percent in the infants over 3500 g. Bell¹², who reported a 33 percent mortality rate in 60 cases, indicated a mean weight of 1300 g for fatal cases and 1700 g for survivors. Tibboel and Molenaar¹³ found an 83 percent mortality rate in premature babies and 57 percent in full-term babies. In our series, the mortality rate was 46 percent for babies under 2500 g and 66 percent for those over 2500 g. All premature babies died. Our study and the reports in the literature indicate that prematurity and/or low birth weight significantly increases the risk of mortality in neonatal peritonitis.

Although there are many studies which emphasize the need to solve hydration problems preoperatively, the effect of dehydration on mortality has not yet been examined^{6,12,15}. The mortality rate was recorded as 86.5 percent in our patients with dehydration, whereas it was 14.3 percent in the patients with normal hydration. We believe that, although the dehydrated patients underwent surgery after their fluid and electrolyte deficits were restored, the irreversible tissue changes that developed due to hypovolemia increased the mortality rate. We also believe, that if the necessity arises, such patients should be transferred to a hospital for medical treatment from other health care centers, and that intravenous fluid and electrolyte transfusion should then be started during or before transport.

Fonkalsrud et al⁶ reported that even though the general condition and prognosis for newborns with sclerema neonatorum is poor, it does not always portend a fatal result. Twenty of the 66 patients we studied had sclerema neonatorum at admission, and they all died. None of the patients with sclerema neonatorum had septicemia at admission. It would not be erroneous to point out here that sclerema neonatorum is a high risk factor for all newborns including those with peritonitis.

Birtch et al⁷ reported a mortality rate of 56 percent for patients with white blood cell counts less than 5000/mm³, 72 percent for those with counts ranging between 5000-15,000/mm³ and 41 percent for those with counts exceeding 15,000/mm³. In our study, the mortality rates with respect to leukocyte count were: 83.3 percent for those with counts under 5000/mm³; 70.6 percent for those with counts ranging between 5000-15,000/mm³ and 33.3 percent for those with counts over 15,000/mm³. Leukocyte counts increase as a reaction to inflammatory events. For those babies with leukocyte counts over 15,000/mm³, the challenge due to peritonitis is great, and hence, the survival rate increases. For babies with white blood cell counts less than 5000/mm³, mortality is higher.

It is believed that the etiology of peritonitis also affects mortality. Tibboel and Molenaar¹³ reported that anastomotic leakage and meconium ileus increase mortality. Bell¹² reported an average mortality rate of 33 percent in his series (50% mortality resulting from perforations that developed after the use of a feeding catheter; 40% mortality in relation to NEC and 10% mortality resulting from spontaneous gastric perforation). In our series, the highest mortality (100%) was due to meconium ileus, congenital megacolon and spontaneous gastric perforation, while a mortality rate of 83.3 percent resulted from anastomotic leakage. We believe, that in addition to peritonitis, repeat operations greatly affect an unfavorable outcome. We found the mortality rate to be 80 percent in patients with intrauterine perforations, 70 percent in patients with intestinal atresia, and 63.3 percent in patients with an imperforate anus. The mortality rate was significantly lower in patients with intussusception (33.3%) and in those with NEC (25%).

The effects the location of a perforation has on mortality have been discussed in several reports. Fonkalsrud et al⁶ reported that perforations are seen in the following descending order of frequency: colon, stomach, ileum, jejunum and duodenum. They found a mortality rate of 88 percent in patients with ileum, cecum and stomach perforations; 75 percent in patients with jejunal perforations and 45 percent in patients with colon and duodenum perforations. Birtch et al⁷ reported that perforations in the newborns they studied were located in order of descending frequency in the ileum, colon, jejunum, duodenum and stomach. They also found that the mortality rate associated with perforations of the cecum was 16 percent, while it was 20 percent in perforations of the stomach, 76 percent in perforations of the duodenum, jejunum and ileum, and 83 percent in other locations of the colon. Bell¹² also encountered perforations of the colon, ileum, stomach, duodenum and jejunum in order of descending frequency. He reported the highest mortality rates in patients with perforations of the duodenum and the lowest in patients with perforations of the stomach. Lloyd¹⁴ reported an overall mortality rate of 71 percent in the cases that he studied with neonatal peritonitis. He found perforations of the stomach to occur more commonly than perforations of the colon, ileum, duodenum and jejunum, in order of descending frequency. He also reported that there were no significant differences in mortality rates. After a search of the literature, we ascertained that the most frequently seen perforations seem to be located in the colon (including the cecum). Perforations of the stomach, ileum and other locations seem to be less^{6,7,12,13}. In this review, the locations of perforations in order of descending frequency were the colon, cecum and the ileum. Most of the fatal cases in our series were due to perforations of the cecum, duodenum and the stomach (100%). Ascending colon perforations caused 75 percent of the fatalities. All of the nine patients with perforations in other locations of the colon survived. The mortality rate of the patients with

perforations of the colon including the cecum (65.3%) did not differ much from the mortality rate of patients with perforations in other parts of the gastrointestinal tract (66.6%).

Postoperative complications also significantly affect mortality¹². In our series, 77.3 percent of the patients with complications died, whereas the mortality rate in the patients with no complications was 68 percent. In contrast, the mortality rate of the patients who underwent a second laparotomy because of other complications rose to 83.3 percent. This rate was 68.5 percent in the patients in whom a second operation was not necessary. Hence, a second surgical trauma that occurs after a short interval is an important factor which results in an increase in mortality.

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