

A Current Appraisal of Problems with Gangrenous Bowel

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Gangrenous bowel most often results from hernia, adhesions and mesenteric insufficiency. The overall mortality rate for 151 cases was 37%. This figure was 20% for hernia, 23% for adhesions and 74% for mesenteric insufficiency. In the latter category where bowel resection was feasible the mortality rate was 40%. Other causes of bowel gangrene had a mortality rate of 28%. In many instances the pathophysiologic processes were of such a nature that current medical expertise has not reached a level of development to effectively cope with the situation. There were, however, a significant number of cases where survival may have been achieved had it not been for deficiencies on the part of the patient, the primary health care personnel or those in attendance at the referral center. The basic keystone for a successful outcome in the management of patients with the gangrenous bowel problem is early surgical intervention. All will be lost if patient exposure to this source of lethal toxins is allowed to proceed to an irreversible stage. Liberal antibiotic administration probably postpones the arrival of intractable hypotension. Other factors which can be expected to improve the survival rate include minimization of technical errors, repair of incidental hernias, elimination of dependence upon nasogastric tubes for the definitive management of patients with complete bowel obstruction (with one or two exceptions), and a firm commitment to the diligent pursuit and early definitive management of postoperative complications.

those where gangrenous bowel was resected at operation or demonstrated at postmortem examination. The overall mortality for the entire group was 37%. Twenty-one of these cases resulted from a variety of miscellaneous conditions including intussusception, carcinomatosis, annular pancreas, diverticulitis, congenital reduplication, pancreatitis and volvulus. The mortality rate among this group was 28%. The remaining 130 cases (86%) had gangrenous bowel as a result of hernia (45 cases), adhesions (43 cases) or mesenteric insufficiency (42 cases) (Table 2). Because of the variety of clinical and pathophysiologic characteristics among these three categories, it was elected to examine them under separate headings.

Hernia

SINCE THE TURN of the century, there has been a sustained decline in mortality rate among patients suffering from bowel obstruction. Most of this improvement has been observed in the area of simple obstruction, where circulatory compromise was not a factor. Unfortunately, an equivalent degree of improvement has not been obtained where gangrenous bowel complicated the problem (Table 1). The purpose of this study was to critically examine the records of 151 patients with bowel gangrene who were treated in our hospital over the past 20 years. Cases included in this series were limited to

The forty-five cases in this group were almost evenly divided between males (24 cases) and female (21 cases). The mortality rate among those 20 cases under 50 years of age was 5% in contrast to the remainder where this figure was 23% (Table 3).

The most common hernia responsible for bowel gangrene was the inguinal variety (Table 4). The mortality among these 22 patients was 14%. The incisional and umbilical category was productive of a considerably higher mortality rate of 21%. Perhaps this is related to the type of patient who usually harbors such a hernia. They are often obese and diabetes is present with a relatively high frequency. Femoral hernia was responsible for bowel gangrene in only three incidences, but the dangerous potential for these lesions is exemplified by a mortality rate of 66%. One would suspect that early surgical

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TABLE 1. Results Achieved in Management of Gangrenous Bowel Problems

Date	Author	Category	No. Cases	Mortality
1950	Becker ⁸	Strangulation	176	24%
1952	Nemir ⁹	Adhesions	11	27%
		Hernia	10	50%
1962	Silen ¹¹	Adhesions	56	23%
1965	Leffall ⁸	Adhesions	29	17%
		Hernia	16	37%
1975	Barnett	Adhesions	43	23%
		Hernia	45	20%
1967	Ottinger ¹⁰	Mesenteric Insufficiency	136	92%
1974	Skinner ¹²	Mesenteric Insufficiency	33	85%
1975	Barnett	Mesenteric Insufficiency	42	74%

intervention for those cases with gangrenous bowel resulting from hernia would be productive of the better survival rate. This position was supported by the fact that 21 cases were operated upon within 36 hours or less and the mortality rate was 5%. The 16 cases operated upon after a longer preoperative time interval, experienced a mortality rate of 25% (Table 5). It was difficult to correlate the length of resected bowel with survival rate. Of interest was the fact that none of the patients who lost bowel segments longer than 100 cm failed to survive (Table 7). The usually severe clinical symptoms resulting from such a lesion may precipitate earlier surgical intervention. The overall mortality for the 45 cases experiencing bowel gangrene from hernia was 20%. Among the 30 cases which were managed before 1965, the mortality rate was 23% while this figure dropped to 13% for the 15 cases treated after this date. The records of the 9 fatalities were examined carefully to determine the circumstances which prevailed. There were three cases where better care in our hospital may have resulted in survival. One patient developed a perforated duodenal ulcer in the postoperative period. This was not expeditiously diagnosed and the patient expired. The second patient was admitted with a large scrotal hernia. He was operated upon for another condition and during the postoperative

TABLE 2. Distribution Among the More Frequent Etiologic Conditions of Bowel Gangrene

Etiology	No. Cases	% of Total Cases
Hernia	45	30
Adhesions	43	28
Mesenteric Insufficiency	42	28
Other Causes	21	14
Total	151	

period the hernia became strangulated with resultant gangrene and death. The third case was a very obese patient who presented with clinical and x-ray evidence of intestinal obstruction along with a past history of peritonitis from a ruptured appendix. A strangulated, gangrenous femoral hernia was discovered 30 hours later. Had these patients been correctly diagnosed and treated, the mortality rate for the entire series may have been 13%. Additionally, two of the remaining fatalities were possibly salvagable, but their management was not under our control. One was observed for an irreducible hernia for four days in a local hospital before being transferred. He died within 30 minutes after arrival in our emergency room. The other case was a similar situation, treated for 5 days before being transferred for definitive treatment. It was not beyond the realm of possibility, then, to have obtained a mortality rate of 9% in this group of patients. Additional lowering of the mortality rate was probably not possible (Table 7). The remaining 4 patients died as a result of extensive congenital anomalies (1 case), progressive, extensive mesenteric venous thromboses (2 cases) and heart failure (1 case).

Adhesion

There were 24 females and 19 males among these patients. The mortality rate was 15% for the 19 patients who were less than 50 years of age and 29% for those above 50 years (Table 3). There were 28 cases managed before 1965 with a mortality of 21%. Those seen after this date numbered 15 and resulted in a mortality of 26%.

TABLE 3. Age Distribution Related to Mortality

	Hernia			Adhesions			Mesenteric Insufficiency		
	No. Cases	%	Mortality	No. Cases	%	Mortality	No. Cases	%	Mortality
50 years of age or less	20	45	5%	19	44	15%	9	20	66%
Over 50 years of age	25	55	23%	24	56	29%	33	80	76%

TABLE 4. *Hernias Responsible for Bowel Gangrene*

Hernia	No. Cases	Mortality
Inguinal	22	14%
Incisional and Umbilical	14	21%
Internal	5	0%
Femoral	3	66%
Spigelian	1	0%
Total	45	20%

The mortality rate achieved among 13 patients who were operated upon within 36 hours from the onset of symptoms was 8%. Where operation was instituted with a greater than 36 hour delay, 24% failed to survive (Table 5). When 100 cm of bowel or less was resected (20 cases) the mortality rate was 25%. Resection of longer segments of bowel (20 cases) revealed a mortality rate of 10% (Table 6). The overall mortality rate for the 43 cases was 23%. There were four possibly preventable deaths which were under our control (Table 7). Two of these cases were managed with long nasogastric tube suction for extended periods of time allowing the development of bowel gangrene with irreversible shock. One patient died from leakage at the site of closure of an inadvertent enterostomy. The remaining patient died from postoperative hemorrhage as evidenced by an abdominal cavity filled with blood at postmortem examination. It would have been possible to achieve a mortality rate of 13% had the above mentioned complications been avoided. Among the fatalities, there were 4 cases of complete bowel obstruction which were treated non-operatively at home or in other hospitals for 3 to 5 days. They had all reached an irreversible stage from bowel gangrene by the time they arrived in our emergency room. Nevertheless, those were probably preventable deaths or must be considered so until proven otherwise. There were two patients suffering from bowel gangrene which we considered to be nonsalvageable. One had extensive abdominal carcinomatosis and the other died of emphysema and diabetic complications two weeks after surgery. We conclude that a mortality rate of 4% may have been possible among these 43 patients with gangrenous bowel resulting from adhesions.

Mesenteric Insufficiency

There were 42 cases in which bowel gangrene resulted from some form of mesenteric circulatory insufficiency. These included arterial embolism, arterial thrombosis, venous thrombosis or low blood flow to the bowel in the absence of vessel occlusion. The diagnosis was made at postmortem examination in 8 cases while 34 received surgical exploration. Among the latter group, 8 cases were closed without additional surgical effort. The remaining 26 cases underwent bowel resection with or without operative maneuvers directed toward restoration of blood flow. There were 28 males and 14 females in this group. Thirty-three (80%) of the cases were past 50 years of age (Table 3). Among those patients (8 cases) where surgical intervention was employed within 35 hours, the mortality rate was 37%. When a longer time interval elapsed (25 cases) the mortality rate was 76% (Table V). Among the 27 cases where bowel was resected, 7 cases received removal of a segment of 125 cm or less with a mortality rate of 43%. When the resected segment exceeded this length (20 cases) the mortality rate was 65% (Table 6). The overall mortality for the 42 cases was 74% (Table 7). Three cases could have been managed more expeditiously with possible lowering of the mortality rate to 67%. One patient was observed for more than 36 hours with a mistaken diagnosis of pancreatitis. A second patient also sustained inordinate delay before receiving surgery. The third patient died because of complications from an abdominal vascular procedure carried out the day before. The entire small bowel was found to be gangrenous at postmortem examination. The remaining 28 patients were considered to be unsalvageable in view of current medical expertise. Nineteen patients exhibited gangrene from the duodenum to the rectum. Six patients died of severe cardiac problems. One patient each was lost because of extensive abdominal tumors, hepatic coma and pulmonary embolism combined with extensive gangrene. Among the 27 cases where bowel resection was carried out, the mortality rate was 40%.

Discussion

Over the years we have developed a position of firm advocacy in favor of the use of antibiotics in patients

TABLE 5. *Mortality Rate Related to Time From Onset of Symptoms to Operation*

	Hernia			Adhesions			Mesenteric Insufficiency		
	No. Cases	Deaths	Mortality Rate	No. Cases	Deaths	Mortality Rate	No. Cases	Deaths	Mortality Rate
36 Hours or less	21	1	5%	13	1	8%	8	3	37%
More than 36 hours	16	4	25%	25	6	24%	25	19	76%
Total Cases	37			38			33		

TABLE 6. Mortality Rate Related to the Length of Bowel Resected

Length of Bowel Resected (cm)	Hernia			Adhesions		
	No. Cases	Deaths	Mortality Rate	No. Cases	Deaths	Mortality Rate
0-100	32	6	18%	20	5	25%
More than 100	6	0	0%	20	2	10%

with intestinal obstruction.¹ Being persuaded that bacterial organisms play a major role in the development of progressive and irreversible hypotension during exposure to gangrenous bowel, we think that antibiotics may significantly postpone the arrival of the irreversible stage. They provide considerable protection against emerging bacteremia and may extend the life of bowel where there is borderline circulation.² Among the antibiotics with which we have had experience, cephalothin and kanamycin have been satisfactory.³

The relative frequency of external hernia versus adhesions as a cause of bowel obstruction has evidenced a progressive reversal: formerly the external hernia was the most common etiologic agent, now adhesions have taken over the lead, especially in the western world. One would think that external hernia would provide a very favorable circumstance for early surgical intervention and effective management of the bowel gangrenous problem. Such has not been effectively realized. Some of the deaths resulted from inordinate delay between the time of onset of symptoms and presentation of the patient for definitive surgical management. Responsibility appears to be divided between patient and primary health care personnel. The entire responsibility does not rest here, though, because external hernias have remained undiscovered for extended periods after arrival at referral centers. The femoral hernia especially may pose a challenge in this respect since large, obvious masses are not characteristic of the condition. The danger is further compounded in the obese patient with generous skin folds and thick layers of adipose tissue. Another variety, the Richter's hernia, may provide an even more subtle lesion culminating in gangrene with all the lethal potential characteristics of this condition. Perhaps these factors may be

related to our especially high mortality rate with femoral hernias. Of the patients who were operated upon within 36 hours, 5% died. Past this period, the corresponding figure was 25%. Incisional and umbilical hernias yielded a mortality rate of 21%. There was a high incidence of obesity and diabetes among this group of patients. The infirmities related to these problems possibly contribute to an explanation of the lower survival rate. Another complication observed after bowel resection consisted of progressive venous thrombosis after bowel resection. It would seem that blood clotting is initiated at the peripheral site of division of the veins and then propagates centrally until those vessels draining the normal bowel are obstructed with progressive infarction of the remaining intestine. The prospect of routine heparinization of all those patients as a prophylactic measure is somehow not overwhelmingly attractive. Our findings suggest that the longer the segment of circulatory embarrassed bowel involved in the hernias, the better the chances for survival. When the amount was less than 100 cm the mortality rate was 18%. Resection of segments longer than this resulted in no mortality. Perhaps the severe, hemodynamic changes, which occur from the extensive lesions, prompts earlier surgical intervention and the shock of oliguric origin can be effectively treated with volume restoration. Another factor of considerable significance in influencing survival is the age of the patient. Our patients under 50 years of age experienced a mortality rate of 5% while 23% of those who were beyond this age group failed to survive.

Gangrenous bowel resulting from adhesions provides an even more dangerous set of circumstances than the conditions which attend strangulated hernia with gangrene. The neck of the hernia sac, which is tight enough to occlude the mesenteric blood supply, will usually disallow the passage of toxic materials into the general peritoneal cavity. In most circumstances of bowel gangrene resulting from adhesions, the entire visceral and parietal peritoneal surfaces are exposed to highly lethal material, heavily laden with bacteria and toxins which they generate. Experimental studies have shown that any of the various intra-abdominal surfaces, including the omentum, is capable of absorbing a lethal dose of this material.⁷ The principle of early operative intervention with removal of devitalized bowel, as with ex-

TABLE 7. Results Among 130 Cases of Bowel Gangrene

Etiology	No. Cases	Actual	Mortality	
			Possible for Us to Achieve	Possible
Adhesions	43	23%	13%	4%
Hernia	45	20%	13%	9%
Total	88	21.5%	13%	6.5%
Mesenteric Insufficiency	42	74%	67%	67%

ternal hernia, must be the fundamental keystone around which any successful surgical therapeutic program is constructed. Episodes of hypotension must be astutely avoided as there is ample evidence that this problem increases susceptibly to the toxins emanating from gangrenous bowel.⁴ Among our patients, those who were operated upon within 36 hours of the onset of symptoms experienced a mortality rate of 8%. Where the period of delay was longer than this interval the fatality rate was 24%. Why has the successful clinical application of this principle been so difficult to achieve? It is true that certain findings may favor the diagnosis of bowel gangrene. These include severe, unrelenting abdominal pain, tachycardia, fever, abdominal tenderness, abdominal rigidity, leukocytosis, localized abdominal distention, and a palpable mass. Wangenstein's admonition, "There are no absolute criteria by which simple and gangrenous bowel obstruction can be differentiated with finality, short of operation" is true today and must be honored if maximal survival rates are to be achieved. Becker⁵ conclusively and finally laid to rest the notion that the two conditions could be distinguished regularly by employing the clinical criteria available during the preoperative period. The patient harboring gangrenous bowel may present with gut obstruction and evident peritonitis. These individuals will have positive x-ray signs of obstruction and this along with the characteristic findings of peritonitis will usually motivate the physician to proceed with surgical intervention. All cases do not present these findings. Some may appear with signs of peritonitis, but in the absence of x-ray findings of obstruction. The practice of treating peritonitis of uncertain etiology nonoperatively might afford the opportunity for irreversible exposure to bacteria and their products because of delay. Then, the possibility also exists that the presenting findings may suggest only intestinal obstruction without evidence of peritoneal irritation. These circumstances may prevail, because of the involvement of a relatively short segment of bowel which might be well protected by surrounding loops of small bowel, and not allow sufficient exposure to precipitate clinical signs. For these reasons we are persuaded that a commitment to the operative management of all cases of complete mechanical bowel obstruction, with one or two exceptions, should be made as soon as the diagnosis is apparent. Judicious decisions must be made between earlier surgical management to terminate exposure to gangrenous bowel toxins versus the utilization of adequate preoperative preparation in order to afford maximum fluid and electrolyte repair to improve the patient as a surgical risk. Appropriate antibiotic administration can play a useful role in gaining more time during the preoperative period, but this approach must not be abused. We no longer employ nasogastric suction tubes, long or short, as the defini-

tive management of complete non-inflammatory, mechanical bowel obstruction. These modalities are of value in the management of partial bowel obstruction, postoperative inflammatory obstruction, paralytic ileus and as an adjunct to surgery in the management of complete bowel obstruction. As with hernia, several of our cases arrived at our hospital after too long a delay as a result of procrastination on the part of the patient or primary health care personnel. Then there were some preventable complications, the responsibility for which must rest upon our shoulders.

Gangrenous bowel problems associated with mesenteric insufficiency are attended by the poorest survival rates of the more common etiologic categories. The majority of these patients are elderly and have other problems which complicate the issue. Advanced atherosclerosis, myocardial disease and diabetes are not uncommon. The diagnosis of threatened bowel viability is not easy to establish in the absence of lumen occlusion, and this is especially true early in the course of the illnesses. The patient who is threatened with this malady must receive intensive support from the beginning. Volume restoration must be kept at an optimal level.⁴ Heparinization should be strongly considered. Antibiotics are best started early in the course of the illness.³ An angiogram involving the superior mesenteric radicles should be obtained. If it shows an area of arterial occlusion, then operative intervention is in order. When the bowel is exposed at surgery, the frankly gangrenous segments should be immediately resected. Like hernias and adhesions, the earlier surgical resection is carried out, the better the chances for survival. In some instances, arterial embolectomy or bypass connections from the superior mesenteric artery to the aorta will reverse toward normal a segment of bowel that appeared to be marginal. Monitoring of the localization of radioactive material and temperature changes in the bowel wall have been alleged to be of value in establishing viability.¹² The second look operation 24 hours later has been helpful in some circumstances where bowel survival could not be predicted at the time of the initial procedure. In spite of these modalities, it is too often that irreversible gangrene is demonstrated from the duodenum to the rectum and a hopeless situation exists. Or a successful surgical procedure is followed by demise from cardiac or pulmonary lesions.

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DISCUSSION

DR. WATTS R. WEBB (Syracuse, New York): I'd like to share with you a recent series of ours which I think bears out very beautifully the lessons that Dr. Barnett has brought to our attention.

This was a series recently analyzed by Dr. Bruce Chamberlain and Dr. Shatilla, from the Community Hospital, in Syracuse. This is a private hospital, and so we were not dealing with the urban indigent, and there are very few of the stoic, reluctant rural patients that give you a completely different caliber to the patients that you are seeing.

These were 103 consecutive cases over the past eight years of mechanical small bowel obstruction. These did exclude those patients who had vascular obstruction, such as the mesenteric thrombosis.

It turned out, of this group, that 50 were strangulated, and 53 were simple obstructions. There were no deaths in the simple obstructions. There were two deaths in the strangulated group, both unrelated to toxic effects; one, an anesthetic problem, and the other, a late bronchopneumonia.

I think the important thing that came out of this was, again, to re-emphasize what Dr. Barnett said, and had been mentioned by Dr. Wangenstein before, that there are no differential characteristics or criteria by which one can separate simple from strangulated bowel early. Whether you look at the fever, the tachycardia, the enzymes, the physical examination for tenderness or rebound tenderness or rigidity, or whether you look at the bowel by x-ray, including barium studies, there was no way to make a differentiation early between simple and strangulated bowel. Late, obviously, you can make it from looking at patients from across the room; but early, there was no way.

Secondly, these patients came—and I think this is probably one of the most important things that was emphasized by Dr. Barnett—from an enlightened group of internists and family physicians, who got them to the surgeon very early in the course of their illness. Essentially all of them who were operated were operated in the first few hours; few as long as 24 hours after arriving in the hospital. There was a brief period of very rapid physiologic resuscitation, with fluids and whatever else was required, including massive antibiotic therapy for the enteric organisms, both aerobic and anaerobic, and then early operation.

There were very few resections. Very few of these patients had gangrenous bowel, because they did get to surgery early, and they were operated early. And this, I think, is the real key to reducing the mortality rate in the strangulated group down to 4%, as Dr. Barnett had predicted you should be able to do.

I think the only ones that we now believe should be handled definitively with a long tube would be, perhaps, those that have carcinomatosis, that have radiation fibrosis, or perhaps those that have already had multiple operations for recurrent obstruction from adhesions. The incidence of gangrene in this group is very, very low, and usually one has opportunity to resuscitate them, treat them with a long tube, and then watch them for other problems as they develop.

DR. JONATHAN E. RHOADS (Philadelphia): I think you will agree that Dr. Barnett and his coauthors have done a very thorough analysis of a large experience with this vexing problem. He did not tell us how many patients they had intercepted early enough so that they didn't

require resection, and, no doubt, were saved. He began with those which had to be resected. So his figures are necessarily higher.

Now, I used the term "vexing" because the results with these conditions have failed to improve in the way one would expect them to have improved, with the many gains in supportive care now applied in clinical practice. Perhaps one must look for some countervailing trends. I will cite three which I suspect may play an adverse role.

The first is the increasing reluctance to use laparotomy as a diagnostic tool. Dr. Dever used to say: "We will now dispel mystery and reveal truth," and proceed to lay the abdomen open. We are so cowed by the possible charge of doing unnecessary operations that we will often wait substantial periods of time in the hope of establishing a secure diagnosis by other means in a patient who presents with a significant possibility of housing a catastrophe.

Second, we have been bombarded with propaganda about preoperative preparation of patients, making up blood volume deficits and correcting fluid and electrolyte deficits. These are important, but with a large bore needle, they can be well advanced in about the same hour or two that it usually takes to get the patient on an operating table. One needs a prompt 24-hour-a-day laboratory, and one needs the realization that total restoration is not a prerequisite to starting the operation. Fifty per cent restoration will usually do, and the second 50% perhaps can be completed more safely a little slowly.

Third, and more applicable to the patients with vascular disease, one needs to be very reluctant to conclude that the patient is hopeless. Some, of course, are hopeless, but with the application of intravenous hyperalimentation to patients with short bowel syndrome, it is surprising how little intestine will suffice for long-term survival.

If, during the first 60 days, nutrition is provided parenterally, the remaining bowel has time to adapt, and has the nutrients it needs for hypertrophy. Dudrick and his associates have had ten patients with 18 inches or less of small bowel whom they have treated successfully in this way.

DR. JUDSON G. RANDOLPH (Washington, D.C.): I would like to agree with Dr. Barnett fully on the premise that only with the immediate removal of gangrenous bowel, when it can be successfully done, are we going to beat this problem, when it involves reasonable lengths of bowel.

I'd like to remind all of you, however, that when most or all of the bowel is involved, some quite different advice might be offered.

I was fortunate, as a junior house officer to be present when Robb Rutledge, of this society, in 1957 did the first mesenteric embolectomy. When I saw him put all that green, black, blue, and purple bowel back into the abdomen, I thought my hero had taken leave of his senses. And yet it did prove that with a second-look approach to this kind of massive bowel insult, a lot of the bowel changed in 48 hours. We have had the experience now in 12 cases with children, entirely, that showed that surgeons who are loath to leave any discolored bowel in the abdomen may actually be taking out viable bowel. In the interest of occasionally preventing the short gut syndrome, I'd like to just show you an illustrative case.

(Slide) This is the appearance of the bowel of a 15-year-old boy who had had an ileal conduit. He already had very markedly reduced renal function, and as you can see, there is nothing wrong with his bowel.