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Scheduled Reoperations (Etappenlavage) for Diffuse Peritonitis

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• ***Etappenlavage*, a new concept of scheduled multiple laparotomies with abdominal lavage for diffuse peritonitis, has been in use since 1979. The purpose of etappenlavage is to ensure exclusion of the infected source, promote maximal elimination of toxic necrotic material, and allow prompt recognition of complications to effect immediate repair. Patients with diffuse peritonitis at high risk of developing multiple system organ failure (as assessed by high scores in the Peritonitis Index Altona and Acute Physiology and Chronic Health Evaluation classifications) were routinely reexplored on a daily basis until evidence of improvement or healing was noted. From 1980 to 1984, 61 patients with intra-abdominal sepsis were treated. Thirty-four cases were due to spontaneous perforation of an intestinal viscus, and 27 cases were secondary to postoperative infections. In 51 cases the primary process was present for more than 48 hours. A total of 235 etappenlavages were performed (mean, 3.9 per patient). In ten cases, additional bowel lacerations were noted and repaired at the second laparotomy. In the last 31 patients, closure with a zipper has facilitated reoperation. No drains were used. After definitive closure, primary wound healing was seen in 79% of cases. The overall mortality in this high-risk group was 22.9%.**
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Despite many technical advances in surgery, mortality from intra-abdominal infection (IAI) remains high, presenting a continuing therapeutic challenge. In an effort to improve treatment results, new operative techniques have been developed and standard therapies reevaluated in the setting of modern intensive care support (Table 1). There is no question that further improvement in therapeutic results with all methods is a necessity.

The application of proper surgical principles is limited in these infections since it is almost impossible to ensure adequate drainage and eliminate the infectious source totally with available methods. Often, the infection spreads to involve other organs before therapy can be instituted.

To face this challenge, in 1979 we designed a new operative method, *etappenlavage*,[13-18] to improve the therapeutic approach concerning two key issues: (1) the elimination of the infectious source, and (2) the evacuation of toxic necrotic material. The method was presented in 1980[13,14] and results were published in 1982[15,16] and in 1984 and 1985.[17,18] Through May 1985, 82 patients have been treated with etappenlavage. The following report deals with the first 61 patients treated from 1980 to 1984.

PATIENTS AND METHODS

Patients

From 1980 to 1984, a total of 437 patients were operated on for IAI (excluding gunshot wounds) at Altona General Hospital, Hamburg, West Germany. Sixty-one patients (14%) had advanced diffuse peritonitis with impending or established multiple system

Table 1.—Mortality Rates of Different Operative Techniques for Intra-abdominal Infection

Source	% of Patients Treated		
	Standard Therapy	Postoperative Lavage	Open Package
Polk and Fry[1]	31	...	...
Fry et al[2]	29	...	...
McKenna et al[3]	60	20	..
Hunt[4]	47	24	...
Stephen and Loewenthal[5]	48	22	.
Esser and Rappen[6]	...	54	...
Halbfass et al[7]	...	27	...
Champault et al[8]	...	...	48
Steinberg[9]	..	...	7
Guivarc'h et al[10]	...	...	25
Duff and Moffat[11]	...	...	38
Hollender et al[12]	...	..	32

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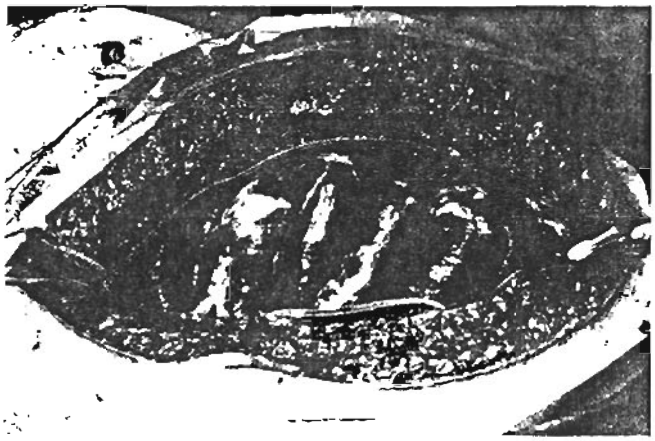

Fig 1.—Abdominal cavity after opening ordinary zipper that was used initially.

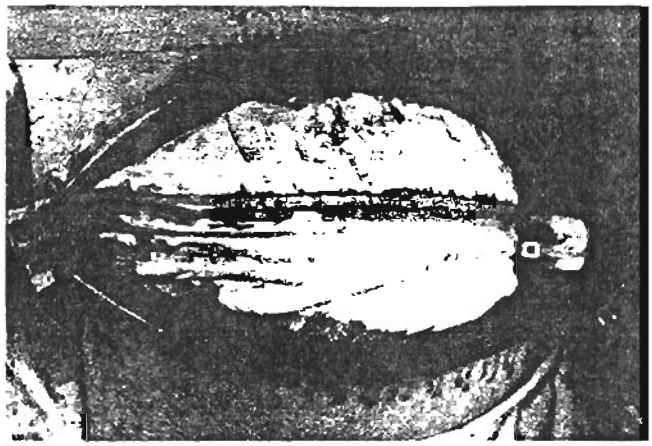

Fig 2.—New zipper developed in our institution. Zipper is fixed to abdominal fascia. Its size can be adapted to the individual situation, ensuring minimal intra-abdominal tension.

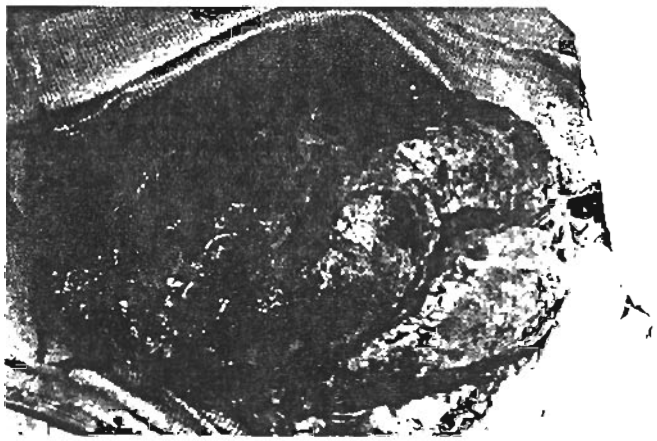

Fig 3.—Female patient, 46 years old, with diffuse peritonitis due to unrecognized iatrogenic colon perforation 15 days before first scheduled treatment. Multiple system organ failure (anuria, pulmonary insufficiency, hepatic failure) was present at initiation of therapy. New zipper adapted to wound, taking into account large intra-abdominal inflammatory edema. Hemofiltration had to be continued.

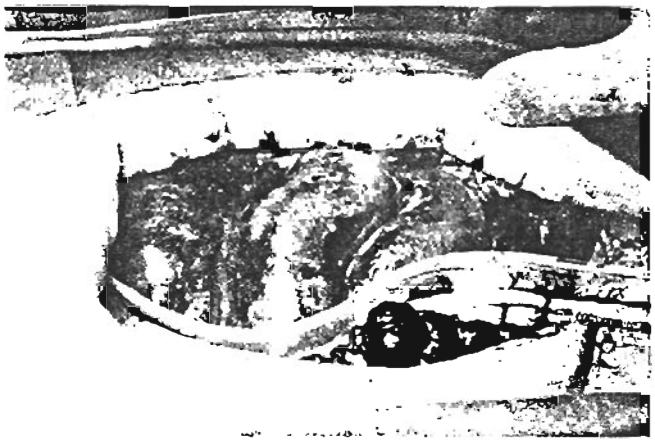

Fig 4.—Abdominal cavity after 23 lavages with bowel function returning to normal. Zipper has been narrowed. Hemofiltration was discontinued.

organ failure. Patients in whom adequate elimination of toxic, necrotic intraperitoneal material was not possible with one operation were considered candidates for the new technique. These patients then underwent temporary abdominal closure when the decision for repeated laparotomy was made at the time of the first operation. Only patients with diffuse peritonitis were entered in the study.

Microbiologic specimens for anaerobic and aerobic cultures were taken initially, and at each subsequent lavage, for identification of pathogens and determination of minimal inhibitory concentrations, according to our previously described methods.[19] In selected cases to evaluate peritoneal healing, peritoneal biopsy specimens were taken for microscopic examination.[18] Antibiotic concentrations (protein-bound and protein-unbound portions) were measured in peritoneal fluid representative of the side of infection.[14]

To classify these critically ill patients more objectively for severity of illness, their admission data was scored according to the Peritonitis Index Altona (PIA) system[20] and the Acute Physiology and Chronic Health Evaluation (APACHE II) system.[21,22]

Operative Technique

As previously stated, the cornerstone of etappenlavage is the decision to reoperate on a daily basis. At the initial operation the infectious source is eliminated either by suture closure, excision and anastomosis, or exteriorization. Any necrotic material is removed and the peritoneal cavity is then irrigated with an average of 8 L of Ringer's lactate solution. Special care is taken to handle the intra-abdominal organs gently to prevent traumatic débridement and to minimize intraperitoneal bleeding. At the end of the procedure, the abdominal cavity is temporarily closed under no tension. In some cases to aid in the closure and to facilitate reexploration, an ordinary zipper was used.[15,22] More recently, we have developed a new zipper with variable sizes[15,23] (Figs 1 to 5). After 24 hours the abdomen is reopened in the operating room, the abdominal cavity is inspected and débrided, bacteriologic specimens are taken, and lavage is performed again with 8 to 10 L of Ringer's lactate solution. Should new sources of contamination be found, the appropriate surgical procedure is performed.

Repeated laparotomies are performed until the exudate is clear, the abdominal cavity is clean, evidence of anastomotic healing is seen, and infectious sources are contained. The abdomen is then definitively closed without drains. The skin is also closed to enable "primary" wound healing.

Fig 5.—Same cavity as shown in Fig 4 but with closed zipper. Patient recovered and primary wound healing occurred.

The patients remain intubated and receive mechanical ventilatory support during the relavage period. Early hemodialysis is used in cases of acute renal failure.

The antibiotic regimen consisted of cefotaxime sodium (2 g/12 hr) with metronidazole hydrochloride (500 mg/12 hr) or moxalactam disodium (2 g/12 hr) or imipenem (1 g/6 hr), all administered intravenously. Cefoxitin sodium alone was used initially but later discontinued when a controlled study[24] demonstrated it to be inferior to the combination of a third generation cephalosporin and metronidazole.

RESULTS

From 1980 to 1984, 61 patients with diffuse peritonitis underwent a total of 235 scheduled repeated laparotomies, ie, 3.9 per patient. The median age was 63 years (16 to 82 years). Sixty-five percent were female patients. Fifty-six percent of the infections were due to perforation of an intestinal viscus secondary to inflammation, ileus, or other causes. Almost half of the infections were due to anastomotic leakage. The median duration from onset of signs of infections to initial etappenlavage was 117 hours (17 to 336 hours). Mechanical ventilatory support was necessary for a median of 19 days (three to 90 days). Other patient data are summarized in Table 2. Initial laboratory values are shown in Table 3.

Multiple system organ failure was present in all our patients. The number of other organs involved is summarized in Table 2. The mean index on the PIA[20] and APACHE II[21,22] systems (Table 4) underscored the high-risk nature of our patients. Leukopenia and leukocytosis were present in 36% and 39% of patients, respectively. Thrombocytopenia was present in 23% of patients. The initial serum creatinine level was elevated in 85% of patients, and abnormal hepatic function tests were present in 89% of patients.

The operations performed were as follows:

Procedures	n
Zipper techniques	31
Small-bowel anastomoses	12
Ileocolostomies	5
Large-bowel anastomoses	4
Closure of duodenal stump	3
Hartmann procedure	9
Simple bowel suture	10
Suture and colostomy	5
Biliary tract reconstruction	7
Lavages only	174

Table 2.—Patients and Methods

Data	n	%
No. of patients (61)		
M	27	44
F	34	56
Postoperative infection	27	41
Nonpostoperative infection	34	56
Origin of infection (68 total infections)		
Stomach/duodenum	11	18
Hepatic-bilipancreatic system	11	18
Jejunum/ileum	15	25
Appendix	1	2
Colon, (intraperitoneal)	21	34
Gynecologic	6	10
Urogenital	1	2
Other	2	3
Appearance of exudate at first operation		
Fibrinous	4	7
Purulent	16	26
Feculent	31	51
Bilious	11	13
Number of additional risks	130	..
Cardiovascular system	49	80
Malignant neoplasms	26	43
Pulmonary system	18	30
Hepatic diseases	11	18
Renal diseases	10	16
Diabetes mellitus	7	12
Other	9	7
Signs of organ system failure at entrance into study		
One organ	5	8
Two organ systems	35	57
Three organ systems	18	30
Four organ systems	3	5

Twenty-one anastomoses healed primarily. Operative complications noted during the subsequent laparotomies included leakage of anastomosis (n = 4), leakage of duodenal stump (n = 3), iatrogenic bowel perforation (n = 2), and cecal fistula (n = 1), for an overall rate of 18%.

All antibiotics, except cefoxitin, yielded sufficiently high concentrations in the peritoneal cavity, as previously published.[20] Elimination of pathogenic bacteria was seen with all antibiotic regimens (except cefoxitin) when adequate operative treatment was performed. The addition of aminoglycoside or other drug combination was necessary in selected cases in which *Pseudomonas aeruginosa*, *Enterobacter cloacae*, or *Enterobacter aerogenes* was cultured. The emergence of *Streptococcus faecalis* was noted in 12% of the patients in the course of their treatment, but in most cases it was eliminated without specific treatment when the abdomen was definitively closed. Intravenous catheters

Table 3.—Initial Laboratory Values of Patients Who Underwent Scheduled Repeated Laparotomies

	n	%
Leukocyte count per cu mm		
<5,000	10	16
5,001-10,000	12	20
10,001-15,000	15	24
>15,000	24	39
Thrombocyte count per cu mm		
<50	4	7
51-100	10	16
101-150	8	13
151-200	6	10
201-250	15	25
>250	18	30
Serum bilirubin, g/dL		
<1.0	7	12
1.0-2.0	19	31
2.1-3.0	12	20
3.1-4.0	5	8
>4.0	18	30
Serum Creatinine, g/dL		
<1.2	9	14
1.2-2.0	35	57
2.1-3.0	13	21
>3.0	4	7

were changed frequently to limit problems due to *Staphylococcus epidermidis*. Epidural anesthesia was used in all patients. Duration of treatment averaged 40 days (range, three to 150 days).

Overall mortality was 22.9% (14/61). The mortality rate was similar for both postoperative IAI patients (22.9%) and patients with spontaneous perforations (23.5%). Primary wound healing was seen in 79% of patients after definitive closure. Complications of closure included late intra-abdominal abscesses in six patients, subcutaneous abscesses in three patients, and wound dehiscence in four patients (Table 5).

COMMENT

Etappenlavage for diffuse peritonitis is a new operative method first presented in the United States in 1980.[13,14] It differs from earlier controlled evisceration[8,11,12,25] since the abdomen is temporarily closed *without* any increase in intra-abdominal pressure. Recent reports by Kerremans et al[26] and Kern et al[27] present their results using similar methods.

The concept of etappenlavage for diffuse peritonitis ensures better elimination of the infectious source, better reduction of the bacterial inoculum in the peritoneal cavity, better elimination of toxic necrotic material, and earlier diagnosis and therapy of postoperative complications. Etappenlavage represents a flexible therapeutic modality that avoids the complications seen with intraperitoneal drains. The relatively low mortality (22.9%) in this high-risk group compares very favorably with conventional surgical therapy (Table 1) and attests to its usefulness.[1-3,8,11,12,26-30]

Table 4.—Classification of Patients According to Peritonitis Index Altona–Risk for Patients With Intra-abdominal Infection*

Reference Points	Mean Index
Died	1.43
Alive	−0.39
All	0.62
SRLAP patients	
Died	1.59
Alive	0.38
All	1.04

*SRLAP indicates scheduled repeated laparotomies.

Table 5.—Results of Etappenlavage

	Fraction	%
Mortality		
Postoperative intra-abdominal infection	6/27	22.2
All other intra-abdominal infections	8/34	23.5
Total	14/61	22.9
Wound healing		
Primary	37/47	78.7
Subcutaneous abscess	3/47	6.3
Wound dehiscense	4/47	8.5
Late-occurring intra-abdominal abscess	3/47	6.3

Not all patients with IAI are suitable candidates for etappenlavage, and it is difficult to exactly define who would benefit from this procedure. Common features seen in our patients included history of symptoms greater than a 48-hour duration, diffuse peritonitis at first operation, and multiple system organ failure.[2] Based on our experience we estimate that between 10% and 20% of nontrauma IAI patients in a community hospital might benefit from etappenlavage.

At Altona General Hospital postoperative IAI accounted for 21% of all patients treated for peritonitis but for 47% of patients in this series. Since postoperative peritonitis can carry a mortality as high as 50%,[31] and given our results, we feel etappenlavage can be particularly useful in postoperative peritonitis.

To help stratify our patients, we classified them according to both the PIA and APACHE II system. According to the PIA index, which classifies prognosis based on five parameters at the initiation of treatment (age, spread of infection, malignancy, cardiovascular risks, and leukopenia), developed at our institution,[20] most patients belonged to a high-risk group with a mean index of 1.04 compared with reference patients who had a mean of 0.62.

By means of discrimination analysis, we were able to predict the correct outcome in 87% of the cases. With a PIA of 1.4, the likelihood of death was 90.5%; with a PIA of 0.39, the likelihood of survival was 85.6% ($t = 7.11$; $df = 89$). The index of reference patients who died was 1.45, whereas the index of patients in our series who died was 1.59. Work with the index is still in progress and results should be considered as preliminary data. By comparison, classification of patients according to the APACHE II system[21,22] resulted in a mean score of 23.4 (score of 17 to 25, n = 41; score of 26 to

30, n=20). The data from Dellinger et al[22] studying 187 patients at five medical centers indicated that patients with these scores had between 35% and 50% mortality. The high-risk nature of our patients is not surprising given the additional risk factors and degree of organ failure seen in our patients (Table 2).

During the lavage period we discovered additional problems not seen at the first laparotomy; these problems might have been missed by other operative techniques. Etappenlavage also allowed inspection of a newly created anastomosis.

Both aerobic and anaerobic bacteria were isolated at the initiation of therapy. Most strains were quickly eliminated with etappenlavage, especially *Escherichia coli* and *Bacteroides fragilis*. Pathogens most likely to persist were *Enterobacter* sp, *P aeruginosa*, streptococci, and *Bacteroides* sp.

We feel that etappenlavage, the technique of scheduled reoperations and lavages, enables better surgical treatment of critically ill patients with diffuse peritonitis. At Altona General Hospital 14% of patients with intra-abdominal infection qualified for etappenlavage. These patients were characterized by diffuse peritonitis, generally of more than 48 hours' duration, by failure of at least two organ systems, and by high scores on the PIA and APACHE II classification.

There are still many questions to be answered. What, if any, influence does etappenlavage have on host defenses? What is the best lavage interval? What place does etappenlavage have when compared with other modalities (eg, percutaneous drainage, controlled evisceration, postoperative lavage) in treatment of patients with intra-abdominal infections? We feel that further prospective studies are necessary to help answer some of these important questions.

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Discussion

JONATHAN L. MEAKINS, MD, Montreal: I was going to show some slides of our own experience in this area, but they look exactly the same as the Figures of the last three cases. The one difference we have in terms of using a zipper is that in the operating room we secure polypropylene (Marlex) mesh to either the skin or the fascia and then assign the patient to the intensive care unit the next day. Depending on the nature of the patient's status, such as obtundation, we do most of the scheduled repeated laparotomies in the intensive care unit.

Concerning the three cases we saw, you would have a difficult time persuading me that those wounds could be closed primarily. Our experience with that kind of bulging gastrointestinal tract that is very edematous and infected, as we have already reviewed with you, simply is not consistent with primary closure because you cannot get the fascia together underneath it. So, what was the difference between the population of patients in whom you could perform primary closure and the type of patients shown in the three cases?

In terms of persuading general surgeons that this is a viable procedure, it becomes very difficult to describe the case in which this procedure is an appropriate form of therapy. We cannot publish cases such as we have seen because it simply takes up too much

space, and we need to define the criteria by which this sort of procedure is indeed useful.

The mortality rate in our experience, about 16 cases to the present time, is 25%. I am embarrassed to say I cannot give you the acute physiological scores of those patients. That is a definite classification of where they stand physiologically together with the predictable mortality based on other patients. Those data are presently being collected. It is only by doing that kind of stratification that we will be able to compare series such as the present one with others and know whether we are indeed identifying and treating the same population of patients. I would submit that in some part we are not. We are certainly not able to close any of the patients we have ever done primarily.

One other thing that can be done occasionally in this situation through the zipper—it is sort of a wild idea—is a right hemicolectomy or a cholecystectomy by just undoing the zipper without going through a lot of the difficulties of reoperating on patients who subsequently get these ischemic problems.

RONALD LEE NICHOLS, MD, New Orleans: The authors differentiated between feculent and purulent appearances of the exudate. Was there any special reason? How did you differentiate between the two kinds?

I have utilized zippers extensively and am curious to ask, did you run across any technical problems?

TOMMY SKAU, MD, Linkoping, Sweden: Other German colleagues, Dr Kern and co-workers [reference 27], also treated patients with generalized peritonitis with scheduled repeated laparotomies in the same way as you demonstrated here. They reported a mortality of 43%. Why did the mortality rates differ so much? Were your patients more severely ill than their patients? In that case, did the mean PIA of your patients significantly differ from that of their patients? How reliable is the PIA as a prognostic index?

Finally, have you planned to compare this treatment regimen with a standard operating procedure in a randomized study to avoid doubts about the significance of your good results?

DAVID AHRENHOLZ, MD, St Paul: What kind of lavage do you perform? Do you use saline or add antibiotics, and how do you decide?

Are all patients taken back to the operating room for reexploration? We are concerned about repeated exposures to the stresses of an anesthetic, so frequently we too will reexplore these patients in the intensive care unit. We have not used zippers. We use polypropylene (Marlex) mesh and to explore the wound we make an incision through the mesh and close the incision with a large monofilament suture when done. If we find evidence of a major problem, the patient is taken to the operating room for more definitive therapy.

GEORGE MACHIEDO, MD, Newark, NJ: I would like to point out that you had a 16% incidence of "delayed" complications such as anastomotic leaks. Were those found at operation or caused by the reoperation?

MARK A. MALANGONI, MD, Louisville: Did you break down all of the adhesions between the various small-intestine loops? If so, do you think this led to any complications?

I am not convinced that your qualitative evaluation of the effluent of the lavage solution is a sufficient indicator to cease further repeated laparotomy. I wonder if you had looked at any quantitative or qualitative cultures of this effluent as an indicator to stop this procedure.

BRIAN J. ROWLANDS, MD, Houston: One of the bits of information that may help us to define this population for repeated laparotomy would be for you to tell us how many patients with a prognostic index below 1 subsequently came to operation.

I have used this technique with Silastic sheeting, and perhaps several benefits to the patient that have not been mentioned should be discussed. For example, this technique avoids closure under tension and may have beneficial effects on hemodynamics, renal function, and the respiratory system by avoiding the splinting of the diaphragm.

DRS WITTMAN and TEICHMANN: First of all, Dr Meakins, you asked what patients are eligible for this type of operation. We think these are patients who have diffuse peritonitis, a history of infection for more than 48 hours, and a PIA index of more than 1. These patients are most likely to develop what we discussed, in the panel discussion, by criteria of impending renal impairment and by impairment of the cardiovascular, pulmonary, and hepatic functions. However, we have problems in defining these patients, and we think about 20% of our patient population would have done well also with the other technique, although the other patients really were so severely sick that we thought it was important that they should be included. In our study group of peritonitis in Germany, we will fix these criteria and design a control study, if possible, to solve these problems. Also, I think it is a good suggestion to use the APS score and APACHE II on our patients; I hope we can report on that.

Dr Nichols asked about the difference between feculent and purulent exudates. We judged the difference by appearance. We did not use any special apparatus to make that differentiation. In addition, we did not have any technical problems with the zipper. It was very easy to suture and resuture it and to take it out later.

Dr Skau asked about the difference between the Kern et al series and our series. I think Dr Kern in southern Germany knew from our institution how the procedure was done. They reported results with our method. But they did not use any index, so we do not really know whether the patient groups are comparable.

Dr Ahrenholz asked about the kind of lavage that was used. We used only Ringer's solution. We did not use any additional antibiotic in the lavages because three years ago we presented data on the kinetics of the antibiotics going into the peritoneal fluid, and we know what is going on in terms of concentration. We did not think local administration was necessary. Our antibiotic treatment was cefotaxime plus metronidazole, in most cases. In some cases we used only moxalactam, and in some recent patients we have used imipenem as an antibiotic.

There was a question concerning how we took the patients to the operating room and whether the patients did withstand the procedures. As we pointed out, most of the patients were receiving general anesthesia in our intensive care unit, and we took them to the operating room to do the lavage. Only in very selected cases were we able to do it in the intensive care unit, but we think that having a proper operating room setup would help us do a better job. The patients did tolerate this procedure without any additional problems.

Dr Malangoni asked about adhesions. If we do break down the adhesions, we do so with gentle débridement during our different operations, if possible.

Another question concerned how we judged when to close the abdomen. We looked for clear exudate. Of course, we also measured bacterial concentrations in the fluid. However, this is extremely difficult because you do not have consistent data, and we are working on that point. In spite of the fact that in some patients we still could isolate some bacteria when the fluid was clear, we did not consider these bacteria to be very pathogenic. So, we cannot give a definite answer.

We think the comment about hemodynamics and renal function, that is, leaving the abdominal cavity without tension, is a very important issue and we think this is one reason why we had some success with the procedure.