Sequential System Failure after Abdominal Surgery

—An Important Problem in Postoperative Care—

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Received for publication April 25, 1984

Summary: During a period from 1976 to 1982, we performed gastrointestinal operation on 2406 cases. Among the 2406 operated cases, 135 (5.3%) developed severe infections. There were 36 (26.7%) cases which fell into the sequential system failure subsequent to these severe postoperative infection. The mortality rate was high at 51.9%. The organ failure began to appear by the second week after the development of infections in the lung, liver, and kidney. When the system failure involved four organs or more, all the patients died. The correlation of the basic cause for the multiple organ failure should not be neglected.

Key words: Multiple organ failure — DIC — Infection — Gastrointestinal surgery — Endotoxin

Introduction

Any major operation can be performed safely as a result of the improvement of postoperative intensive care in recent years. However, multiple organs occasionally fail, simultaneously or sequentially, after major operations. In this paper, the clinical problems of sequential system failure concurrent with severe infections after gastrointestinal surgery are presented and the concept, diagnostic criteria and problems associated with treatment of this syndrome are discussed.

our clinic—390 on the esophagus, 894 on the stomach and duodenum, 296 on the liver, pancreas and gallbladder, 101 on the small bowel, 294 on the large bowel and 431 on the rectum. 135 (5.6%) of the 2406 patients developed severe infections (Table 1). The mortality rate for the severely infected patients was high at 51.9%. There were 36 (26.7%) patients who experienced sequential system failure subsequent to severe postoperative infection. 29 (80.6%) of these patients died.

Results

The incidence of postoperative system failure was highest for the lungs (29%), followed by the kidneys (16%), the liver (15%), the gastrointestinal tract (11%)

Material and Method

Between 1976 and 1982, 2406 gastrointestinal operations were performed in

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TABLE 1
Analysis of postoperative infections

Organ	No. of operations	Infections	No. of deaths	Mortality rate
Esophagus	390	22 (5.6%)	19	86.4%
Stomach and Duodenum	894	69 (7.7%)	32	46.4%
Liver Pancreas and Gallbladder	296	10 (3.4%)	4	40.4%
Small bowel	101	11 (10.9%)	5	45.5%
Large bowel	294	8 (2.7%)	6	26.7%
Rectum	431	15 (3.5%)	4	26.7%
Total	2406	135 (5.6%)	70	51.9%

Of 135 patients with severe infections, 36 had multiple organ system failure

TABLE 2
Number of cases of MOF involving a organ

	Lung	Liver	Kidney	GI tract bleeding	Heart	DIC	Total
Cases	32	17	20	12	11	17	109
(%)	29.4%	15.6%	16.3%	11.0%	10.1%	15.6%	100%

TABLE 3
Days from post operative infections to MOF

	Lung	Liver	Kidney	GI tract bleeding	Heart	DIC
Mean days	13	15	14	18	26	23

TABLE 4
MOF and its prognosis

No. of affected organs	Cases	No. of deaths	Mortality rate
2	11	6	54.5%
3	16	14	87.5%
4	6	6	100.0%
5	3	3	100.0%
Total	36	29	80.6%

and the heart (10 %).

The incidence of disseminated intravascular coagulation (DIC) was 15.6 % (Table 2). The organ failure began to appear by the second week after the development of infections in the lung, liver, and kidney (Table 3). The failure of three organ

systems was observed most frequently with 16 cases followed by failure of two organ systems in 11 cases, failure of four organ systems in 6 cases and failure of five organ systems in 3 cases. The prognosis for each multiple organ failure is shown in Table 4.

When the system failure involved four organs or more, all the patients died.

Discussion

In recent years, our understanding of the pathophysiology of functional disorders of major organs has become deeper. Therapeutic results with severe patients have improved markedly with the techno-

logical improvement of intensive care. On the other hand, it should be noted that multiple organs not responding to positive treatment develop a simultaneous or sequential system failure in some cases. Such a state is called a multiple organ failure or progressive organ failure.

It is only recently that researchers began having an interest in this pathophysiology. Tilney et al. (1973) were the first to describe multiple organ failure as a problem in the postoperative care of ruptured abdominal aortic aneurysms.

The mortality rate was high for patients who developed acute renal failure after an operation for this disease and required hemodialysis. The cause of death was not acute renal failure, but functional failure of other organs such as the lung, liver, heart and central nervous system which occurred during the clinical course of acute renal failure.

Phrases such as "multiple organ failures" and "progressive system failures", have been developed (Churchill, 1975) which indicate a shift in emphasis from failure of a single organ.

Acute renal failure or liver function disorder was considered a single pathophysiological problem affecting the prognosis of patients with severe trauma or after extensive surgical intervention.

Now multiple organ failures must be considered.

In its implication his remark is correlated with the improvement of artificial organs.

At present, it has become possible to treat diseases such as liver function disorder, heart failure, or DIC, while supporting the function of other organs with medical instruments.

For instance, hemodialysis can be used for renal failure and a respirator for respiratory failure. Multiple organ failure indicates a pathophysiological state in which two or more major organs fall simultaneously into a state of functional disorder.

Exactly what constitutes a disorder differs for each organ and from one investigator to another (Churchill, 1975; Eisman, 1977).

Generally, it implies a state in which the function of the organ concerned is almost completely lost. The clinical criteria for a functional disorder is presently 1) a need for mechanical ventilation of the lung with a PaO_2 in room air of not more than 60 mmHg, according to arterial blood gas analysis 2) bundle branch block or cardiac arrest occurring during the clinical course, with a central venous pressure not less than 20 cmH₂O in the heart, 3) 100 units or more of S-GOT and S-GPT, with the total bilirubin above 3 mg/dl, 4) gastrointestinal bleeding, 5) a need for hemodialysis, that is, BUN is not less than 50 mg/dl and creatinine not less than 3 mg/dl, 6) absence of central nervous system response, except to pain and irritation and 7) presence of acute DIC, a fibrinogen degradation product (FDP) of not less than 40, a blood platelet count not more than 100,000 and fibrinogen not more than 150 mg/dl. The criteria mentioned above are considered useful for the early detection and treatment of multiple organ failure.

Two types of multiple organ failure are conceivable. The same factor which causes disturbances of one organ may induce anomalies in other organs. Factors such as DIC attendant upon infection, shock and liver cirrhosis, severe trauma, a major operation and massive blood infusion can be mentioned. Also, there may be a change in the correlation between organs.

That is, renal failure could cause disturbances between the organs. For instance, the regulation of water and electrolytes and the pH of body fluids becomes abnormal with changes in the excretion of waste matter. Pneumonia can develop due to hyperkalemia, a disorder of central nervous system, a dysfunction of myocardium, lung edema and uremia, and can lead to respiratory insufficiency. The fac-

tor most concerned with the development of multiple organ failure appears to be infection (Fry et al. 1980).

Peritonitis and pleuritis were the bases for 85 % of the multiple organ failures, and gram-positive bacteria were usually found upon bacteriological examination. It is well known that a liver function disorder, gastrointestinal bleeding, disturbance of consciousness and infarction of myocardium can also develop from sepsis due to endotoxin. When an infection is suspected to be the cause of a persistent fever of unknown cause and leukocytosis after an operation, the limulus test can be conducted to determine whether there is endotoxemia.

There also are many reports which suggest that an intraabdominal abscess should be suspected in patients with progressive pulmonary disturbances and renal disorders of unknown cause, and that an exploratory laparotomy should be performed (Fry et al. 1980).

The second large factor for multiple organ deficiencies is DIC. Micro-thrombi occur in a diffusive manner and micro-necrotic foci or hemorrhagic foci form extensively in tissues and organs and appear to cause disturbances in various organs.

DIC is produced by malignant tumors, trauma, shock and obstetric-gynecologic diseases, and appears to be triggered mainly by sepsis. With infections, shock or trauma, the stage is set for multiple organ failures to occur easily.

The probability of multiple organ failures varies greatly depending on the type of disease. It is approximately 7 % when an emergency operation has been performed for trauma and 1.2-1.8 % for patients after abdominal surgeries.

In 7 years, multiple organ failures were encountered in 36 or 1.49 % of 2406 cases of gastrointestinal tract surgery.

These were due to postoperative complications from severe infections. The causative bacteria in the infected patients

were mainly gram-negative bacteria. In the upper gastrointestinal tract, mixed infections with gram-positive bacteria were also found frequently. The order of impairment of organs when multiple organ failure has occurred differs from one study to another.

In this study, the lung and liver were impaired early and impairment of the kidney, heart and gastrointestinal tract occurred sequentially, several days later. The lungs were most susceptible to impairment, followed by the kidneys and liver.

If one organ system failed, the mortality rate was 29 percent.

The mortality rates became higher as the number of organ systems failures increased, being 55 % with failure of two organ systems, 88 % with failure of three organ systems and 100 % with failure of four organ systems.

With simultaneous or sequential organ system failure, the treatment depends on the order of organ impairment.

The simultaneous failure of multiple organs poses some problems, such as which organ should be treated first and/or should all the organs be treated simultaneously. Many clinicians are of the opinion that artificial organs should be used first.

For instance, pulmonary insufficiency controllable with a respirator and renal failure manageable by hemodialysis should receive treatment first. Actually, it is clear that not all the problems can be resolved by these procedures. The correction of the basic cause for the multiple organ failure should not be neglected.

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