Clinical Investigation of the Portacaval Shunt:

IV. A Report of Early Survival from the Emergency Operation

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This is a report of 50 patients who were bleeding massively from varices and upon whom emergency life-saving portacaval shunts were performed because of uncontrollable hemorrhage. Records were selected from the files of 12 Veterans Administration Hospitals and comprise a substudy within a prospective cooperative investigation of the role of portacaval shunt in the prevention and treatment of hemorrhage from esophagogastric varices and survival from chronic liver disease.

Since January 1, 1962, investigators at these institutions have screened, classified, and randomized for therapy cirrhotic patients who qualified for study under a uniform protocol. Details of the study design and preliminary survival analyses are contained in previously published reports by Jackson *et al.*[10, 11]

The aim of this report is to study the various factors influencing 30-day or early survival after emergency operation; and to add additional data to the literature on this subject, which to the present has been relatively sparse. The largest series reported as of this writing has been 40 cases.[15]

Although in the final analysis the value of a treatment program is principally determined by long-term survival, the relatively short follow-up of many of our cases restricts this report to an analysis of factors influencing 30 day (or operative) mortality. A comprehensive survival analysis exceeding 30 days is to be reported later.

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Methods and Materials

Selection of the Patient for Emergency Operation

Definition of Emergency. In all 50 cases the operations were performed not later than 48 hours after cessation of bleeding (often while actively bleeding) thus eliminating instances in which the operation was delayed beyond 2 days after the cessation of bleeding. Thus, this series (in the opinion of the authors and the operating surgeons) consists of life-saving operations and is to be differentiated from shunts performed when hemorrhage has been considered controlled. An additional 25 patients were screened but did not conform to this criterion for emergency operation and therefore are not included.

Source of Patients. Nine of the 50 patients had been previously randomized in the Therapeutic Series (one or more episodes of bleeding from varices) of the main Cooperative Study. The diagnosis of Laennec's cirrhosis and esophageal varices had been established prior to the acute bleeding episode. Patients had, therefore, received an average of 2.5 months of liver therapy within the controlled study.

Forty-one of the 50 had not been previously enrolled in the Cooperative Study. Their diagnoses were established by evaluation at the time of admission. In other words, 41 were new patients who because of acute conditions could not be randomized under the study protocol, since it excluded the emergency operations. Any patient whose condition was too far advanced or terminal was not selected for emergency operative treatment.

All 50 patients were operated upon after failure of medical management. Therefore, this series is highly selective and includes only patients who were operated upon to save life.

Etiology of Cirrhosis. The etiology of cirrhosis was considered to include one or more of the following: (1) alcoholism (2) dietary or nutritional (3) homologus serum hepatitis (4) infectious hepatitis. Alcoholism was defined as the daily ingestion of alcoholic beverages punctuated by "binges" for prolonged periods, usually several years. Alcohol was the principal etiology in 46 or 92% of 50 patients.

Age and Sex. The youngest patient was 31 and the oldest was 73 years. The average age was 49. All were men.

Physical Examination. The following physical observations were considered important and confirmation by two observers was required before recording.

1. Nutrition; defined as the "habitus of the patient," i.e., obese, cachetic, or normal.

2. Ascites; considered to be minimal when shifting dullness was present. Moderate ascites was recorded as shifting dullness with bulging of flanks. A tense abdomen, distended with fluid and without palpable organs was considered marked ascites.

3. Jaundice; considered a recordable physical sign only when the serum bilirubin was above 1.5 mg./100 ml. (Mild: 1.5–3.0 mg./100 ml. Moderate: 3.0–6.0 mg./100 ml. Severe: 6.0 mg./100 ml. and above.)

4. Hepatomegaly; liver which is palpable below the right costal margin.

5. Splenomegaly; a palpable spleen confirmed at laparotomy.

6. Dependent Edema; presacral, pretibial, or ankle edema.

Laboratory Studies. For all patients in the main cooperative study the following laboratory studies were performed at repeated intervals: (1) CBC and urinalysis (2) Bromsulfalein retention (4) serum albumin (4) thymol turbidity (5) serum bilirubin (6) serum alkaline phosphatase (7) prothrombin activity (8) blood ammonia (9) cephalin flocculation (10) Serum Glutamic Oxalacetic Transaminase. Patients who had not been previously enrolled in the main study received a limited evaluation because of their emergency status and the confines of time.

Leukopenia was diagnosed when two or more white counts were below 4,000. Thrombocytopenia was two platelet counts below 100,000. The diagnosis of hypersplenism required, in addition to leukopenia and thrombocytopenia, confirmation by a pathologist or hematologist after bone marrow biopsy.

The admission hematocrit was considered an indication of the severity of hemorrhage; i.e., hematocrit below 20% represented severe hemorrhage.

Criteria for the Diagnosis of Cirrhosis. A liver biopsy was obtained from each of the 50 patients and confirmed the clinical and laboratory diagnosis of cirrhosis or chronic liver disease. Three unstained slides of each liver biopsy, together with a copy of the report of the local pathologist, were forwarded to the consulting pathologist (Dr. Albert G. Smith, Professor and Chairman, Dept. of Pathology, Louisiana State University School of Medicine, Shreveport, Louisiana). One of the following histological changes must have been noted: (1) periportal fibrosis (2) fatty change (metamorphosis moderate to great in amount) (3) nodular regeneration (4) necrosis.

Diagnoses excluded were: Wilson's Disease, Cardiac cirrhosis, and Hemochromatosis.

Criteria for the Diagnosis of Esophagogastric Varices. The diagnosis was made when the varices were demonstrated by observation at surgical operation or by one or more of the following two methods of examination:

1. *Endoscopy.* (with preliminary esophagram) Varices were classified as follows:

Grade I. Small, superficial, tortuous, sigmoid-shaped, or straight veins, measuring 2 mm. or less in diameter.

Grade II. Dilated veins having a diameter of 2–4 mm., which, without compression with the tip of the instrument, were slightly elevated above the surface.

Grade III. These measure in excess of 4 mm. in diameter, are slate-gray or dusky red in color, and protrude in the relaxed esophagus without compression by the tip of the instrument.

Grade IV. Large varices in the maximal phase.

2. *Splenoportography.* The technic of splenoportography was as follows:

Radiopaque material was deposited into the portal vein by first injecting it into the splenic pulp. Usually 40 ml. were injected into the pulp (2–3 cm. beneath the capsule) at a rate of 5–6 ml. per second. Serial roentgenograms were taken at one second intervals at the beginning or midway through the injection phase for a total of 15 or more exposures. The procedure was performed in the operating room with the abdomen open, or percutaneously under local anesthesia.

Criteria for the Diagnosis of Portal Hypertension. Portal venous pressure was measured directly from the portal vein (or a major tributory) or indirectly from the splenic pulp. Splenic pulp pressure has been demonstrated to be a reliable index of portal venous pressure.[1]

Significant hypertension was diagnosed when the pressure exceeded 20 mm. Hg at the designated zero level at 12.0 cm. anterior to the spine (the level of the anterior surface of the 2nd lumbar vertebrae) or the table upon which the patient is lying supine.

The presence of collateral veins of either the splenic or portal systems or both demonstrated by percutaneous splenoportography or direct venography was considered evidence of obstructed portal venous flow.

Percutaneous splenic manometry was performed in 12 instances (at the same time of percutaneous splenoportography). Portal system pressure measurements were performed in all 50 patients at the operating table by water (saline) manometer and later conversion to mm. Hg.

Preoperative Management

Blood Transfusion. All patients received whole blood transfusions to restore circulating volume. The amount of blood infused prior to operation was considered an index of the severity of bleeding (greater than 1,500 cc. considered "severe."). Blood transfusions in ratio of one fresh unit (plastic bag or siliconized bottles and less than 6 hours old) to every two units of stored bank blood was recommended when possible to maintain the hematocrit above 30 (hematocrit check every 6 hours).

Iced Lavage. In most patients stomachs were irrigated with ice water (or saline) via gastric tube every 15–30 minutes using 200 cc. of ice saline. Wangesteen suction was continuous during intervals between irrigations.

Balloon Tamponade. A trial of balloon tamponade was discretionary and was used in 30 of the 50 patients. The Sengstoken-Blakemore tube was inserted and 300–350 ml. of air inflated the gastric portion. Six hundred to 1,000 Gm. of traction was placed on the gastric balloon. If bleeding was not controlled, the esophageal balloon was then inflated to provide a minimum of 25 cm. H_2O (18.5 mm. Hg) or maximum of 45 cm. H_2O (34 mm. Hg) of pressure. The esophageal balloon was deflated every 4 hours for 15 to 20 minutes. Tamponade was not continued beyond 24 hours.

Vasopressin Therapy. Surgical pituitrin was administered initially in 35 of the 50 patients. Twenty units of pituitrin were dissolved in 200 ml. 5% glucose and water and allowed to run in for 30 minutes. This was repeated every 3 to 4 hours when necessary.

Hypothermia. Total hypothermia was used during operation in six patients. Gastric hypothermia, as a nonoperative means of controlling variceal bleeding, was not employed in this series.

TABLE 1. *Assigned Risk According to Child's Classification**

Class	OP Death	Survival	Total
A	5	7	12
B	10	15	25
C	9	3	12
Inc. information	0	1	1
Total	24	26	50

*Group Designation	"A" Minimal	"B" Moderate	"C" Advanced
Serum bilirubin (mg./100 ml.]	Below 2.0	2.0–3.0	Over 3.0
Serum albumin (mg./100 ml.)	Over 3.5	3.0–3.5	Under 3.0
Ascites	None	Easily controlled	Poorly controlled
Neurological disorder	None	Minimal	Advanced, "comma"
Nutrition	Excellent	Good	Poor, "wasting"

Clinical and Laboratory Classification of Patients with Cirrhosis in Terms of Hepatic Functional Reserve

All 50 patients were classified according to the degree of functional hepatic reserve as devised by Child.[3] The operative mortality was related to each category of assigned risk (Table 1).

Surgical Treatment

As a general policy emergency shunting was discouraged except as life-saving procedure. The emergency operation was only considered in a patient with cirrhosis and esophagogastric varices with massive hemorrhage under the following conditions: (1) The patient was free from advanced complicating conditions, such as cardiovascular disease, pulmonary disease, or renal disease; or, from far advanced liver deterioration. (2) The balloon tamponade did not control hemorrhage in the first 24 hours or upon release of pressure, the hemorrhage recurred within the first 72 hours. (3) Blood for transfusion was in short supply or the patient had a rare type. (4) There were no serious clotting defects.

TABLE 2. *Drop in Portal Pressure*

	OP Death	Survival	Total
Less than 10 mm. Hg	9 (64%)	5 (36%)	14 (100%)
Greater than 10 mm. Hg	12 (40%)	18 (60%)	30 (100%)
No information	3 (50%)	3 (50%)	6 (100%)

In all 50 patients end-to-side portacaval shunts were performed through variations of a right subcostal incision in all but two instances (i.e., one thoraco-abdominal incision and one midline).

The choice of technic was left to the operating surgeon.

The duration of the operative procedure was recorded in each case as the interval between skin incision and closure.

Results

Physical Findings

Hepatomegaly. Thirty-four or 68% of the group were diagnosed as having hepatomegaly. The number of operative deaths with hepatomegaly was approximately the same as the number of survivors, and the proportion of operative deaths did not differ significantly between the group with and without hepatomegaly.

Ascites. Ascitic fluid was present in 30 patients (60%). Among those with ascites at the time of operation 17 (56%) died within 30 days. By contrast, among the 16 patients without ascites six died (37%).

Dependent Edema. Ten patients had edema prior to operation. Three died within 30 days and seven survived.

Jaundice. There were eight deaths among 20 patients who had "mild" icterus, two death among eight, "moderate," and five deaths in seven who were severely jaundiced.

Splenomegaly. Of the 21 patients with splenomegaly, nine died within 30 days and 12 survived. Five of the 21 had white blood counts below 4,000, and four of the 21 patients had platelet counts below 100,000; all of these patients survived.

Nutrition. Twelve patients were obese, 29 were of normal habitus, and nine were cachectic. Among the 41 patients who were either obese or normal, 18 died. In contrast, among nine cachectic patients six died.

Laboratory Findings

Hematocrit. There were nine operative deaths in 16 patients with hematocrits below 20% and 14 operative deaths in 33 patients in the higher hematocrit range.

White Blood Count. Among the six patients who had counts below 4,000 there were four operative deaths, while among 38 who had counts above 4,000 there were 15 deaths.

Prothrombin Time. Of the 15 patients whose prothrombin times were less than 50% there were eight deaths. Among the 27 patients whose prothrombin time was greater than 50% there were 11 deaths.

Blood Ammonia. This determination was recorded only infrequently (14 out of 50 patients). Six patients had abnormally elevated blood ammonia (greater than 120 μg./100 ml.); three died within 30 days.

Serum Albumin. Seven of 41 patients had preoperative albumin determinations below 3.8 Gm./100 ml., and there were three operative deaths. Of the remaining 34 patients whose serum albumin levels were normal (3.8–4.6 Gm./100 ml.) there were 17 operative deaths.

Other Laboratory Values. Other tests of liver function (i.e., BSP, Cephalin flocculation, etc.) were not recorded in sufficient frequency to permit assessment.

Size of Varices

Among 27 instances where varices were graded preoperatively, seven patients were operated upon with grade I–III varices and 20 patients with grade IV–V varices. Regardless of the estimated size of varices the number of deaths and survivals were approximately the same (i.e., 12 vs 15).

Classification of Liver Disease (Table 1)

When patients were grouped into categories of risk as devised by Child[3] operative deaths increased in proportion to the degree of liver failure. In classes A and B (minimal to moderate hepatic failure) there were approximately 40% operative deaths. The percentage of operative deaths increased to 75% in class C (advanced hepatic failure).

Portography and Portal Pressure

Preoperative percutaneous splenoportography was performed in 19 patients and revealed esophagogastric varices in all. Three additional attempts were technically unsatisfactory.

Manometry was also performed in 12 instances at the time of percutaneous splenoportography. The mean preoperative splenic pulp pressure was 30.2 mm. Hg with extremes of 40.0 mm. Hg and 25.0 mm. Hg.

The mean preoperative pressure measured at the operating table (average from splenic pulp, portal vein, or branch) was 30.1 mm. Hg with extremes of 14.8 mm. Hg and 40.9 mm. Hg. In two instances initial pressures at laparotomy were within normal (14.8 mm. Hg, and 17 mm. Hg).

Pressure Differential as a Result of Shunting (Table 2). When the pressure differential as a result of shunting was less than 10 mm. Hg, there were nine operative deaths and five survivors. In contrast, when the pressure differential was greater than 10 mm. Hg there were 12 operative deaths as compared to 18 survivors.

TABLE 3. *Blood Transfusions*

Preoperative			
Units	OP Death	Survival	Total
0–3	4 (30%)	9 (70%)	13 (100%)
4 and over	20 (54%)	17 (46%)	37 (100%)
During Operation			
Units	OP Death	Survival	Total
3–6	10 (48%)	11 (52%)	21 (100%)
7–18	14 (48%)	15 (52%)	29 (100%)

TABLE 4. *Duration of Operation*

Hours	OP Death	Survival	Total
3–5½	10 (33%)	20 (67%)	30 (100%)
6–8½	14 (70%)	6 (30%)	20 (100%)

Blood Transfusions (Table 3)

Preoperative Blood Transfusions. Among the 13 patients in whom three or less units were used there were 4 operative deaths. In contrast, among the 37 patients in which four or greater units were replaced, there were 20 operative deaths.

Blood Administered During Operation. Among the 21 patients receiving 3 to 6 units there were 10 operative deaths. Among 29 patients receiving 7 to 18 units there were 14 operative deaths.

Duration of Operation (Table 4)

Table 4 relates 30-day mortality with duration of operative procedure. Among 30 operations recorded as less than six hours, there were 10 operative deaths. Among 20 operations over more than 6 hours, there were 14 operative deaths.

Cause of Death (Table 5)

The overall operative death rate (30 day mortality) was 48%. Hepatic failure accounted for 12 (or 50%) operative deaths. Variceal rebleeding accounted for six deaths (or 25%). The remaining were miscellaneous, such as myocardial infarction and renal failure.

Of six variceal rebleeding deaths, in one the portal pressure was not lowered by shunting (probably for a technical reason) and persistence of hemorrhage is partially explained. In another there was a 5 mm. Hg pre-post shunt pressure differential, and the shunt was patent at autopsy. In four, shunts were found at autopsy to have thrombosed.

TABLE 5. *Causes of Death (30-Day Mortality)*

Liver failure	12 (50%)
Recurrent variceal hemorrhage	6 (25%)
Congestive heart failure	2 (9%)
Myocardial infarction	1 (4%)
Cardiac arrest	1 (4%)
Hemorrhage from tracheostomy tube	1 (4%)
Renal failure	1 (4%)
Total deaths	24 (100%)

Previously Treated Cirrhotics (VA Cooperative Study) versus Untreated (Table 6)

Table 6 compares survival of the nine randomized patients with the 41 who had not been under study control, and who, because of their emergency nature, were not randomized under terms of the main study protocol.

Among the nine randomized patients there were only two operative deaths. In contrast, among 41 non-randomized patients there were 22 operative deaths (54%). Four out of nine patients of the randomized group had minimal hepatic disease (Child's Class A) prior to operation, as compared to only nine in class A among 41 patients of those in the non-randomized group.

Discussion

A variety of procedures have been employed with varying degrees of success in the emergency control of variceal bleeding including thoracic duct lymph drainage,[14] esophagogastrectomy,[6] splenectomy or splenorenal shunt,[7] gastric devascularization,[5] transesophageal and transgastric varix ligation,[4, 16] mesocaval shunt,[12] Womack's Operation[13] and decompression of the portal vein via umbilical vein.[9] Portacaval shunt, however, remains the most frequently employed emergency operation for variceal hemorrhage. It was originally suggested by O'Sullivan in 1956.[17]

The overall operative mortality among 50 patients reported in this series was 48%; essentially the same as the 52% mortality in an unselected series reported by Orloff.[15]

Physical evidence of advanced liver disease, i.e., ascites, severe jaundice, and cachexia, had notable influence on operative mortality. Each appeared to be an ominous sign and adversely affected survival. Neither hepatomegaly, dependent edema, splenomegaly or mild to moderate jaundice appeared of themselves to influence survival.

Better early survival occurred among patients with higher initial hematocrits. This equates severity of preoperative hemorrhage with higher operative risk. Survival appears to be adversely affected by leukopenia, possibly reflecting influences of hypersplenism.

The only liver function tests performed under the emergency circumstances which justified analysis were prothrombin time, blood ammonia, and serum albumin. Operative mortality appeared to be influenced only by prothrombin time, which when abnormal, was associated with a higher percentage of operative deaths.

Among patients who had been randomized for medical treatment in the main study, there were proportionately fewer operative deaths, probably the result of previous controlled medical treatment and selection procedure prior to operation.

Child's mortality figures for 128 elective portacaval shunts were: Combined Class A and B, 4.3% mortality; Class C, 58% mortality. The prognostic implications therefore compare favorably in both studies: the prediction of operative success is considerably less favorable among patients having advanced (Class C) impairment of liver function by these criteria.

The accuracy of percutaneous splenoportography in this series (86% diagnostic accuracy) compares favorably with the 75% accuracy in 83 cases reported by Peternel *et al.*[18] The advantages of preoperative percutaneous splenoportography and manometry in the assessment of hepatic portal flow and collateral flow has also been reported by several investigators; notably, Britton,[2] Jackson,[8] and Warren.[19]

An explanation for two patients with what we consider normal pre-shunt portal pressure (14.8 mm. Hg, and 17 mm. Hg) at laparotomy can only be speculative. It is possible that each had effectively formed shunts by extensive collateralization; however, variceal bleeding can occur at any level of portal pressure. It more commonly occurs at mean pressures of 25.0 mm. Hg in our experience.[8]

It appeared that the more efficient shunts had a more favorable prognosis. There was a higher death rate when pressure differentials before and after shunting were low.

The higher operative mortality for patients receiving massive replacement of whole blood preoperatively probably reflects severity of initial hemorrhage as well as physiologic disturbances. The total amount of blood (mean 22.3 units) required by the average patient from three days before operation through 30 days after was surprising.

The adverse effect of lengthy operating time upon survival is probably a composite of toxic effects, prolonged anesthesia, catabolic effects of stress, renal insult, etc. A meaningful analysis of this observation is difficult, but it appears that prolonged operative exposure beyond 6 hours was associated with a higher 30-day mortality.

In most reported elective and emergency series there is a variable incidence of postoperative bleeding. After portacaval shunt, however, the incidence of recurrent bleeding from proved varices is rare, and in this series suggested occluded or malfunctioning shunt.

Summary

This study relates experience with 50 cirrhotic patients in a non-randomized, noncontrolled study who were operated upon as life-saving measures for exanguinating variceal hemorrhage. In each patient end-to-side portacaval shunt was performed.

From an analysis of these data, it appears that operative mortality (i.e., 30-day mortality) may be related to the following factors:

(1) *Hepatic Functional Reserve.* Patients with physical and laboratory evidence of advanced hepatic insult survived operation poorly. Patients who had previously been screened for medical therapy in the main VA Cooperative Study, and had a few months intensive therapy, had higher survival rates than patients without this advantage.

(2) *Severity of Total Blood Loss.* In patients whose initial hemorrhage was considered severe, as evidenced by low initial hematocrit (less than 20%) and high preoperative blood transfusion requirements (greater than 1,500 cc.), the mortality rate was higher than in those patients whose hemorrhage was less profuse.

(3) *Hemodynamic Efficiency of Shunt.* The success of shunting was correlated in part with portal pressure differentials before and after shunting. Among patients in whom the post-shunt portal pressure reflected notable reduction (i.e., greater than 10 mm. Hg) of portal hypertension there was a higher survival rate than in patients in whom the pressure differential reflected little change.

(4) *Duration of Operation.* There was a sharp rise in 30-day mortality among patients for whom the duration of operating time for various reasons extended beyond 6 hours.

TABLE 6. *Survival (Randomized vs. Non-randomized)*

	Operative Mortality	Survivors	Total
Randomized patients	2 (22.2%)	7 (77.8%)	9 (100%)
Non-randomized patients	22 (53.7%)	19 (46.3%)	41 (100%)

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