

## THE BACTERIAL FLORA OF THE BLOOD STREAM IN THE KOREAN BATTLE CASUALTY\*

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THE PURPOSE OF this study has been to describe the bacterial flora of the blood stream of the severely injured casualty at the time of his arrival at the forward surgical hospital. The primary intent has been to describe the flora for the purpose of therapy. A secondary purpose has been to survey this problem in patients in deep shock in order to ascertain the possible secondary development of bacteremia due to permeation of the ischemic bowel.<sup>1-3</sup>

The importance of this information lies in the fact that many casualties had large contaminated wounds of the soft tissues, and others had perforations of the gastrointestinal tract with peritoneal contamination.

This study was carried out on the Eastern Front of Korea in the months of January, 1952, to June, 1953. The tactical conditions at this time were stable to such an extent that evacuation of casualties was optimal. Except when wounded on patrol, the casualty characteristically reached the battalion aid station within one hour after injury. At the aid station, in addition to the vital resuscitative measures, antibiotics were often administered, a measure less frequently employed by medical officers of the Korean Army. Six hundred thousand units of penicillin, intramuscularly, was the treatment

most frequently given. The severely injured casualty was then immediately evacuated by helicopter or ambulance. At the time of arrival at the forward surgical hospital, the casualty was taken immediately to the resuscitation ward. At this time blood cultures were obtained; the most severely wounded men being selected.

This study, therefore, is a study of the severely wounded casualty as he reached the forward hospital at an average time of 4.0 hours and a mean time of 3.5 hours after injury.

### METHODS AND MATERIALS

After preparation of the skin with iodine and alcohol, venous blood was drawn under aseptic technic. One to 3 ml. of blood was added to 7 ml. of dextrose broth for aerobic culture. For anaerobic culture 5 ml. of blood was added to a 100-ml. bottle containing 50 ml. of trypticase soy broth and carbon dioxide at a subatmospheric pressure (Becton-Dickinson vacuum-tainer bottle). In the first study, penicillinase was added to all media at the time of inoculation. After an intubation period of 48 hours or longer, smears were examined and at the same time blood agar plates and tubes of cooked meat broth were inoculated. The latter were incubated 72 hours, then subcultured for recovery of *Clostridia*. The original culture tubes were retained for one to

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two months and checked for delayed growth.

A total of 170 patients was studied; the study being carried out by two separate laboratories. In the first group, 117 casualties were studied. Thirty-five patients (30 per cent) of this group had received penicillin prior to culture. Of the group receiving penicillin, eight patients had also received 1.0 Gm. of streptomycin. In the second group, 52 patients were studied. Thirty-seven patients (71 per cent) had received penicillin

TABLE I. *The Bacterial Flora of the Blood Stream.*

Series	Number of Patients	Number of Positive Cultures	Percentage
I.....	117	12	10
II.....	53	11	21
TOTAL.....	170	23	13.5

and four of the patients had also received streptomycin. The time lag was similar in the two studies.

For the purpose of this presentation only, patients were considered in shock if they presented signs of blood volume deficiency in association with a systolic blood pressure below 100 mm. systolic and 70 mm. diastolic. If these signs were accentuated and associated with a systolic blood pressure below 50 mm., the patient was considered to be in severe shock. Accordingly, in the first series,

TABLE II. *Organisms Isolated by Blood Culture—Series I.*

Patient	Aerobic	Anaerobic
A	Staphylococcus albus, non-hemolytic....	Negative
B	Staphylococcus albus.....	Negative
C	Bacillus species.....	Negative
	Staphylococcus albus.....	
D	Bacillus species.....	Negative
E	Bacillus species.....	Negative
F	Staphylococcus albus.....	Negative
G	Staphylococcus albus, hemolytic and non-hemolytic.....	Negative
H	Staphylococcus albus.....	Negative
I	Staphylococcus, hemolytic.....	Negative
J	Corynebacterium hofmanni.....	Negative
	Bacillus species.....	
	Staphylococcus, hemolytic.....	
L	Streptococcus, gamma.....	Negative

TABLE III. *Organisms Isolated by Blood Culture—Series II.*

Patient	Aerobic	Anaerobic
A	Staphylococcus, non-hemolytic....	Negative
	Corynebacterium hofmanni.....	
B	Staphylococcus*.....	Negative
	Bacillus species.....	
	Staphylococcus, non-hemolytic....	
C	Bacillus species.....	Negative
D	Bacillus species.....	Negative
E	Achromobacter.....	Negative
F	Streptococcus, beta hemolytic....	Negative
G	Streptococcus, beta hemolytic....	Negative
	Streptococcus, non-hemolytic....	
H	Streptococcus, non-hemolytic....	Negative
	Staphylococcus†.....	
I	Streptococcus, non-hemolytic....	Negative
	Staphylococcus†.....	
J	Negative.....	Clostridium sporogenes
		Clostridium sporogenes
		Clostridium lentoputrescens
K	Negative.....	

\*Hemolytic, salt resistant, mannite fermenting, coagulase negative.

†Hemolytic, salt resistant, non-mannite fermenting, coagulase negative.

59 patients (50 per cent) were in shock on admission to the hospital, of whom 26 (22 per cent of the total) were in deep shock. Twenty-eight patients (24 per cent) had visceral perforations. Of the second group, 31 patients (60 per cent) were in shock, of whom 12 (20 per cent of the total) were in deep shock. Sixteen patients (31 per cent) of the second series had visceral perforations. The two groups, therefore, consisted of casualties with comparable degrees of injury. Twenty normal soldiers served as controls. In addition, 20 contaminated cultures were shipped from the forward hospital to the base laboratory and then recultured to establish the feasibility of shipment.

RESULTS

Of the 20 contaminated controls, all contained viable bacteria after shipment. Of the 20 control blood cultures from the normal soldiers, all were negative.

The results of the two studies of battle casualties were similar (Table I). In the first study of 117 casualties, 12 cultures (10

per cent) were positive. The predominant organisms grown were *staphylococcus albus* and the organisms of the *Bacillus* species which are among the chief organisms of the skin and the air, respectively (Table II). It is entirely conceivable that several of these positive cultures were the result of contamination, as blood was sometimes very difficult to obtain from the vasoconstricted, shocked patient.

The results of the second series differed in that streptococcal strains were cultured from four casualties and clostridia were cultured twice.\* Coliform organisms were found only once. The incidence of positive cultures was 21 per cent (Table III).

The incidence of positive cultures could not be related to the time lag, degree of shock, visceral perforation, nor the previous administration of antibiotics.

#### DISCUSSION

In the over-all study of 170 severely injured battle casualties, 23 positive blood cultures (13.5 per cent) were found. In spite of care in technic, several of these may have represented contamination from the skin or air so that the figure is maximal. It is believed that the actual incidence of positive peripheral blood stream cultures lies around 4 to 6 per cent in the most severely injured battle casualties and that the wound is the

\* This observation of a clostridial bacteremia was noted repeatedly in an early, unreported series and in a patient with peritonitis. No obvious break in technic was noted. The observation is, therefore, reported with the reservation that in spite of careful technic, contamination can never be completely excluded.

portal of entry. Vascular collapse did not appear to alter this incidence. The results of this study in no way invalidates the observations of others regarding the role of bacteria in the late refractory shock of animals.<sup>1-3</sup> However, of the 30 patients studied who died of their wounds, only three had positive cultures. Moreover, of the 38 patients in severe shock for an average of 7.3 hours (ranging from 1 to 36 hours) only three were positive; one having been in shock two hours and the other two for four hours.

#### SUMMARY

A study of the bacterial flora of the blood stream in the severely injured battle casualty was carried out by two laboratories in Korea and Japan. One hundred and seventy severely injured casualties were studied by blood culture methods at the time of admission to the forward hospital. The incidence of positive cultures was 13.5 per cent. Correction for possible contamination might lower this incidence to 4 to 6 per cent.

The degree of shock, the type of injury, the time lag, and the previous antibiotic therapy did not affect the incidence of positive cultures.

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