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Pathogenic role of *Bacillus cereus* in wound infections in the tropics

M S Dryden MA MB *Department of Microbiology, St Thomas's Hospital, London SE1*

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Summary
A bacteriological survey was undertaken on clinically infected traumatic wounds amongst a group of young and fit Operation Raleigh members, who were living and working in a remote area of Costa Rican rain forest. All infected wounds were swabbed before treatment and, where possible, at intervals during treatment. Swabs were also obtained from the nose and throat of each patient. All swabs were stored by desiccation in sterile silica gel for culture at a later date. Culture revealed a high rate of isolation of *Bacillus cereus* from the wounds. The organism was commonly isolated in pure and heavy growth. Contamination by *B. cereus* was considered and excluded experimentally. Preliminary toxological studies have shown that the majority of the isolates produce a necrotic exotoxin, in keeping with the clinical findings. These results suggest that *B. cereus* caused significant sepsis in this series of traumatic wounds.

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Introduction
A bacteriological survey of wound infections was carried out amongst a group of Operation Raleigh expedition members, working in a remote rain forest in Costa Rica, Central America, during February and March 1985. The aim of the study was to examine the bacteriological flora of infected wounds in a small group of people, living in a remote tropical area, isolated from other human contact. The technical problems of working under these conditions had to be overcome.

Methods
During a six-week period in the jungle, 21 healthy expedition members of both sexes, aged 18–27 years, were asked to present to the medical officer with any traumatic skin lesions. Any clinically infected lesions, as defined by the presence of pus and cellulitis, were included in the study. Infected lacerations and insect bites were the most common medical complaint. Most lacerations resulted from injury by rocks, thorns and machetes. Mosquitoes and ticks caused the majority of bites. One wound was the result of attack by a wild peccary. The lesions were frequently contaminated by soil and grit, and the rate of infection of minor lesions was high.

Before treatment, the skin surrounding each wound was cleaned with alcohol and a specimen of pus was obtained on a cotton swab. Each patient had a nose and throat swab taken. A total of 36 wounds were swabbed, from 18 patients. The swabs were placed in vials containing sterile silica gel, using a method designed for streptococcal surveys in foreign countries or remote areas where access to laboratory facilities is unavailable[1].

On return to the laboratory, up to two months later, the swabs were plated directly on blood agar which was incubated at 37°C, aerobically and anaerobically. To exclude possible contamination of the sterile materials, unused samples, including silica gel, vials and alcohol, were cultured on return to the laboratory and found to have remained sterile. Inadequate desiccation of the swabs by the silica gel, a further source of error, was excluded by a laboratory

trial. Swabs were taken of a mixed broth culture of *Bacillus cereus* and *Streptococcus pyogenes*, in numbers simulating those which might be expected to be found in an infected wound. These swabs were stored in unused silica gel vials. Culture of these swabs at various intervals confirmed the survival of both organisms for up to three months.

Results

Eighteen out of 21 expedition members presented with clinically infected traumatic wounds. Fifteen patients had more than one infected wound during the study period. In total, 36 wounds were swabbed. For the majority of cases, treatment involved topical antisepsis and dressing. A few severe wound infections were treated with ampicillin and flucloxacillin. Wound healing time varied from 4 to 28 days.

B. cereus was isolated from 28 of the 36 wounds. In 26 of the isolates *B. cereus* grew in pure heavy growth. In the other 2, there was a heavy mixed growth of *B. cereus* and *Strep. pyogenes*. *Strep. pyogenes* alone was isolated from one wound, and *Staph. aureus* alone from one other. *B. cereus* was isolated from the wounds of 14 of the 18 patients, and from 15 nose swabs and 5 throat swabs.

Twenty of the *B. cereus* isolates were serotyped and tested for toxin production. Twelve of the isolates were of serotype V; the others were of various different serotypes. None of the strains is commonly encountered in the United Kingdom. Preliminary toxigenic studies, using methods previously described[2], showed that 16 isolates were high toxin producers, 3 were intermediate toxin producers and only one a low toxin producer.

Discussion

Bacillus cereus is well described as an aetiological agent in food poisoning[3]. There have been many reports of non-gastrointestinal infections caused by *B. cereus* in man[4,5] and animals[6]. In man, *B. cereus* infections have been described covering a wide range of clinical conditions[2,7], including bronchopneumonia, bacteraemia, meningitis, endocarditis, osteomyelitis, panophthalmitis, urinary tract infections and an outbreak in a maternity unit (E R Youngs, personal communication 1984). Aerobic spore-bearers have long been associated with traumatic wounds[8], and there have been recent reports of *B. cereus* playing a pathogenic role in wound infections[9,10]. One of these reports described a series of significant *B. cereus* infections in which nearly half involved traumatic or surgical wounds of the limbs[9].

Several studies have previously shown a high prevalence of streptococcal wound infection in the tropics[11,12]. In this survey, the high recovery rate of *B. cereus* and the low recovery rate of *Strep. pyogenes* was surprising. Initially it was felt that the isolation of *B. cereus* represented contamination of materials, but this was ruled out and the efficacy of the desiccated swab method was confirmed.

The expedition members were continually dusty and dirty throughout the six weeks in the jungle. It is likely that all the patients were covered in saprophytic organisms. That *B. cereus* was amongst these organisms is suggested by the high carriage rate (83% of nose swabs and 28% of throat swabs). In most cases *B. cereus* was isolated from the infected wounds in pure and heavy growth. Previous reports have shown that moderate to heavy growth of Bacillus sp. from wounds may often be of clinical significance, but is frequently regarded as a contaminant in the laboratory[9]. On this evidence alone, it is reasonable to suggest that *B. cereus* was playing a significant role in the pathogenesis of these wound infections.

Further supportive evidence was provided by the toxigenic studies. Some strains of *B. cereus* produce a necrotic exotoxin. A close relationship has been described between the virulence of *B. cereus* isolates, as defined clinically, and the production of exotoxin by the strain[13]. Sixteen of the strains were in the highest category of exotoxin production. This fits in with the clinical picture of severe local infection and surrounding cellulitis. It is interesting to note that none of the strains isolated were of serotypes commonly found in the UK. Nevertheless, it is important to remember that toxigenic strains of *B. cereus* are found in this country and infections due to this organism are probably underdiagnosed. *B. cereus* should never be dismissed as a contaminant without due consideration, when it is isolated from any site in the body, but particularly from traumatic and surgical wounds.

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