Investigation of the Epidemiology and Microbiology of Wounds and Wound Infections in the Royal Thai Army (RTA)

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OBJECTIVES :

1. To describe the extent and distribution (by agent and anatomical site) of wounds, incurred as a result of combat, appearing at 1° and 2° surgical centers.

2. To establish the types and quantities of microbial flora coexisting with these injuries.

3. To relate microbial occurrence to risk of overt infection, severity and type of injury, subsequent treatment and residual morbidity.

4. To ascertain the value of the injury/microbiology/infection approach for use in predicting infection potential in combat injuries.

BACKGROUND : The pilot study and training period described previously demonstrated the feasibility of the establishment of a program to monitor care of an injured soldier through the chain of evacuation of the RTA.

Problems encountered in the establishment of this project, excepting those of study design and logistics, were mainly concerned with the gaining and holding of the interest of key personnel within the government and within the medical care system. For the practicing physicians, a continuations program of service was incorporated into the study design. For the government official, the potential long-term benefits in increased accuracy of prognosis and the eventual establishment of a hospital supported infection surveillance program were stressed.

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METHODS :

Study Sites : At the initiation of this study, the military hospital and the provincial hospital at Phitsanuloke were the focus of the chain of evacuation of patients injured near the Laotian border in Northeast Thailand. This changed during the period of study and therefore reduced the number of casualties, but did not change the distribution pattern of the injuries.

Pramongkutklao Hospital, Bangkok was used as followup for patients enrolled at Phitsanuloke, and as a referral center for other hospitals in Thailand.

Microbiological Sample Collection : Both aerobic and anaerobic specimens were routinely collected from the wound site and a blood culture was taken concurrently. Wound specimens consisted of tissue, fluid exudate or swab of infection surface, and were collected on admission, at surgery, and when clinically indicated. Wound edge and deep swabs were taken for comparison when a penetrating wound was evident. Cultures were inoculated into transport media and a blood culture bottle. Wound cultures were reported only when flora specimens and antibiotic sensitivity data was available. Blood specimens for culture were taken for culture on three successive days following any clinical indication of septicemia, following surgery, and following any positive culture report, and also taken if no specimen has been otherwise required for 3 days. Blood cultures were incubated for a minimum of 72 hours, read at 24, 48 and 72 hours, and then submitted to the main laboratory for further study. Any positive bottle culture was gram stained and examined microscopically prior to subculture.

Epidemiologic Data Collection : Each combat injured soldier was interviewed by a nurse as soon after admission as feasible. The interview concerned demographic data on the patient, type of injury agent, if known (booby trap, mine, shoulder weapon, hand weapon, etc.), geographic location of the area in which the injury was sustained and activities at the time of injury. The nurse made an objective assessment of injury severity using a standard scale. From the patient's chart, a clinical description of all injuries and concurrent medical problems (diabetes, helminthiasis, etc.), therapy prior to admission, initial laboratory findings, and place and length of prior hospitalizations with this injury were abstracted.

RESULTS : Tables 1 and 2 present the demographic pattern of patients incurring combat injuries and subsequently requiring treatment at Pramongkutklao Hospital. The incidence of injury was heaviest on the lower ranking enlisted personnel in the 20-24 year old age group. The agent of injury (Table 3) was closely related to the anatomical location of the injury (Table 4). The extensive use of the land mine as an anti-personnel weapon by insurgent forces in Thailand has resulted in the high percentage of lower extremity injuries incurred.

Because extremity injuries predominated this series, further analysis will be specific for those type injuries. Similar analyses can and have been performed for other types of injuries.

Tables 5 and 6 present the bacterial isolates derived from extremity wounds. While enteric organisms, normally indigenous to man, were the predominating group, Pseudomonas species were isolated more often than any other single organism.

Table 7 presents the length of hospitalization in lower extremity injuries in relation to the results of bacterial cultures taken an admission. Evidence of the presence of bacteria regardless of type, appeared to add approximately one month to the overall hospitalization in patients whose sole or primary injury was to the lower extremities. Antibiotic usage in these patients usually involved multiple drug therapy with combinations that included Ampicillin, Kanamycin and/or Penicillin G (Table 8). The antibiotic usage in patients from whom Pseudomonas sp. was isolated varied from that presented in Table 8 only in that there were fewer patients in which a great number of different antibiotics (over five) were used.

Of the 275 patients admitted to Pramongkutklao during the course of this study, 125 cases of lower extremity fracture and 43 upper extremity fractures were encountered. Often there were fractures of more than one extremity in an individual. Of the 125 lower extremity fractures (to include phalanges through femur), 92(73.6%) eventually required some degree of amputation (Table 9). Eight upper extremity fractures (18.1% of the total) required ablative surgery. The majority of primary lower extremity amputations were traumatic. The extensive use of the land mine as an anti-personnel device is reflected here again. In spite of nearly universal evidence of infection on admission, non-amputated fractures arriving at Pramongkutklao sustained a less than 25% amputation rate in the lower extremity and an under 5% rate in the upper extremity.

The 78 patients identified at and followed from Phitsanuloke presented a chance to compare primary and secondary health care facilities. Because over half of the combat casualities at Phitsanuloke were civilian, the age range was much broader (8-50) and activities interupted by combat were much less military in nature (farming, highway construction and hunting). Rifle bullets were the agents of injury in a higher percentage of cases in the primary center than the secondary, but injuries from land mines continued to predominate. There was a slightly less skewed array of injuries encountered at Phitsanuloke than at the secondary center in Bangkok, but lower extremity injuries were still over twice as common as any other anatomical location. Mean length of hospitalization was also considerably shorter in the outlying hospitals as compared to Pramongkutklao, 38 days vs 90+ days.

Bacterial isolate types from Phitsanuloke showed a very different distribution from that of Bangkok. While at Pramongkutklao, isolates of *Pseudomonas sp.* represented over one third of all isolates, at the primary health care centers, Pseudomonas was identified in less than 10% of isolates. In non-pseudomonal isolates, *Staphylococcus epidermidis* and *Enterobacter sp.*, especially *E. agglomerans*, represented a much higher percentage of wound associated isolates in the primary centers than in the secondary. *Staphylococcus aureus* was slightly more common in the secondary center. Antibiotic sensitivity patterns for bacteria isolated did not vary by level of care.

Three culture techniques were assessed as to agreement in bacterial isolation. Surface swabs agreed only occasionally with swabs taken from deep within the wound (Table 10). Except in the instance of the isolation of *E. coli*, given that an organism was isolated by one technique, in less than half of the cases could the organism be isolated from the other swab. The situation was similar for tissue specimens taken for culture. In no case was there more than 50% agreement between tissue specimen and swab specimen.

Data collection for this project is complete, but reduction and analysis will continue into the next year.

Table 1. Military Status of Combat Casualty Patients at Pramongkutklao Hospital, Bangkok, Thailand, 1978-9.

	No.		%
Military and Police	223		
Private		130	58
NCO		79	36
Officer		14	6
Civilian	52		

Table 2. Age of Combat Casualty Patients at Pramongkutklao Hospital, Bangkok, Thailand, 1978-9.

Age	
≤19	7
20-24	165
25-29	53
30-39	34
40-49	14
≥50	2

Table 3. Agent of Injury in Combat Casualty Patients at Pramongkutklao Hospital, Bangkok, Thailand, 1978-9.

	No.	%
Land mine	123	42
Mortar, grenade	53	18
Rifle	105	36
Pistol	4	1
Artillery	2	1
Punji stick	1	-
Fire	1	-

* 16 cases received injuries from 2 agents

Table 4. Anatomical Locations of Injury in Combat Casualty Patient at Pramongkutklao Hospital, Bangkok, Thailand, 1978-9.

	No.	%
Head and neck	28	10
Thorax	34	12
Abd & genitalia	10	4
Upper extremity	46	17
Lower extremity	135	49
Multiple injuries involving more that one of the above classifications	22	8

Table 5. Culture Results from Lower Extremity Combat Injuries Seen at Pramongkutklao Hospital 1978-1979.

	Lower Extremity (N=188)	Foot (N=32)
Pure Culture		
Pseudomonas sp.	40	5
Enteric organisms	44	5
Staphylococcus aureus	2	1
Mima sp.	3	
Bacillus subtilis	2	
Klebsiella sp.	2	
Candida		1
Skin flora	6	2
Mixed Culture		
Pseudomonas with enteric organisms	17	1
Pseudomonas with Staphylococcus	1	
Pseudomonas with skin flora	3	
Pseudomonas with enteric organisms and Staphylococcus	1	2
Pseudomonas with enteric organisms and Klebsiella	5	1
Enteric organisms with Staphyloccus	4	
Enteric organisms with Klebsiella	4	1
Enteric organisms with skin flora	2	1
Staphylococcus with Klebsiella	2	1
No Growth	50	11

Table 6. Culture Results from Combat Injuries of the Upper Extremity Seen at Pramongkutklao Hospital (N=48)

Pure Culture	
Pseudomonas sp.	7
Enteric organisms	5
Staphylococcus aureus	2
Mima sp.	2
Herellea sp.	1
Acinetobactor	1
Skin flora	1
Mixed Culture	
Pseudomonas with staphylococcus	2
Pseudomonas with enteric organisms	1
Pseudomonas with skin flora	2
Pseudomonas with enterics and staphylococcus	1
Enterics with staphylococcus	1
Enterics with Klebsiella and streptococcus	1
No Bacterial Growth	28

Table 7. Length of Hospitalization in Lower Extremity Injuries Incurred as a Result of Combat by Bacteria Isolated on Admission.

Organism (number of isolates)	Days of Hospitalization <7	8-14	15-30	31-45	46-90	91-120	121-180	>180	Mean length of hospital-ization (days)
Pseudomonas sp. (67)	1		5	9*	8	11	8	25	132
Enterobacter sp. (51)	2*	1	3	3*	10	5	9	18	130
Herellea sp. (23)	1*	1	4	2*	1	1	5	8	125
Klebsiella sp. (20)				3		2	8	7	154
Staphylococcus aureus (16)			3	1	2	2	4	4	121
Mima sp. (3)				1	1			1	75
No bacterial growth (51)	2	4	7	5	10	4	10	9	98

* Pt. expired in 1 case.

Table 8. Antibiotic Therapy of Lower Extremity Injury Patients N=155.

	No.	%
Ampicillin/Amoxicillin	108	70
Kanamycin	76	49
Penicillin G	60	39
Bactrim/Septrin	49	32
Gentamicin	30	19
Chloramphenicol	24	16
Cloxacillin	12	8
Tetracycline	7	5
Streptomycin	4	3
Lincomycin	2	1

Table 9. Sequellae of Fractures Pramongkutklao Hospital, Bangkok, Thailand, 1978-1979.

Fractures :	
Lower Extremity (N=125)	
Amputation prior to admission at Pramongkutklao Hospital	82(65.6%)
Amputation after admission to Pramongkutklao Hospital	10(8.0%)
Evidence of infection on admission in non-amputated fractures	33(76.7%)
Upper Extremity (N=43)	
Amputation prior to admission at Pramongkutklao Hospital	6(13.9%)
Amputation after admission to Pramongkutklao Hospital	2(4.7%)
Evidence of infection on admission in non-amputated fractures	31(83.8%)

Table 10. Agreement Between Lower Extremity Wound Culture Samples Pramongkutklao Hospital, Bangkok, Thailand.

Organism	Deep and surface swabs agree	Deep and surface swabs disagree	Swabs and tissue agree	Swabs and tissue disagree
Escherichieae coli	5	3	1	2
Enterobacter aerogenes		2		2
Enterobacter cloacae	2	4	1	2
Herellea sp.	2	3	1	1
Klebsiella sp.	2	3	1	5
Pseudomonas sp.	4	10	4	6
Staphylococcus aureus	1	5	1	1
Streptococcus fecalis		2	1	2