An Overview of Open Fractures in the Philippine General Hospital Setting

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ABSTRACT: Two hundred forty-five cases of open fractures managed in the Philippine General Hospital from August 1985 to July 1987 were reviewed with regard to factors that may contribute to the causation of infection. Based on the Stepwise Logistic Regression Analysis, the following factors were identified as significant: type of open fracture, mechanism of injury, and presence of related injuries which also required emergency treatment. Thirty-nine open fractures developed infection resulting in an over-all infection rate of 15.9%. Gram negative organisms were isolated as the etiologic agents in 89.7% of these cases. Aminoglycosides are thus suggested as the first-line drug in the management of all types of open fractures.

INTRODUCTION

All open fractures must be treated as emergencies. It cannot be overemphasized that the salient treatment, which includes debridement and intravenous antibiotic administration, plays a major role in the outcome of the injury. Gustilo, in 1982, strongly advised that open fractures be cared for within 8 hours of injury, provided that other more emergent problems have been recognized and resolved. Ideally, these patients undergo debridement at the operating room, are admitted and given parenteral antibiotics prior to, during, and up to 3 days following surgery. Other treatment modalities include primary closure for types I and II open fractures, based on Gustilo's classification of open fractures (Table 1).

Unfortunately, the guidelines set for managing these open fractures cannot all be met in the Philippine General Hospital setting. Majority of its patients cannot afford the cost of a 3-day course of intravenous antibiotics. It is also a fact that this government hospital has difficulties in meeting the great demands exerted on its limited number of health personnel, operating rooms, and medical supplies. All these contribute to the less than ideal management of open fractures.

TABLE 1
Classification of Open Fractures.

Type I:	puncture wound 1 cm. or less in diameter, and relatively clean; minimal soft tissue involvement; injury usually a simple, transverse, short oblique fracture with minimal comminution.
Type II:	laceration more than 1 cm. long, without extensive soft tissue damage, with a minimal to moderate crushing component.
Type III:	one with extensive damage to the soft neurovascular sructures, otfen caused by a high velocity injury or a severe crushing component.

It is therefore the aim of this study to:

1) provide an overview of open fractures in the PGH setting;

2) describe the factors that would most influence the development of acute infection as a complication,

3) determine the etiologic organisms present in the acutely infected cases and possibly reevaluate the present protocol for antibiotic coverage for open fractures.

METHOD OF RESEARCH

All cases of open fractures seen in the Philippine General Hospital from August 1985 to July 1987 were reviewed. Inclusion criteria consisted of the following:

1) treated within 24 hours of injury;

2) not previously managed in another center;

3) remained under the care of the Orthopedic residents for at least 2 weeks post injury.

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The following factors were taken into consideration: age; sex; fracture type; fracture configuration; site of fracture; mechanism of injury; presence of related injuries which required emergency treatment; debridement (locale and timing); stabilizing procedure with pins, nails, or plates; antibiotic therapy (route and dose), complications (amputation, infection, mortality); and length of hospital stay. Excluded from the study were open fractures of the hand since it is felt that the classification is not truly reflective of these injuries. The study does not also deal with complications that appeared much later, such as those of delayed union or non-union. All results were then gathered and subjected to statistical analysis using the BMDPLR Logistic Regression Test.

RESULTS

A total of 316 open fractures were seen at the PGH from August 1985 to July 1987. Two hundred forty-five cases were included in this study. There were 207 males (84%) and 38 females (16%) with ages ranging from 1 to 74 years (mean = 26 years).

The frequency of open fractures based on their fracture types are seen in Table 2.

The leg was the most common site of open fracture followed by the forearm and the foot (Figure 1).

The most common mechanisms of injury were the gunshot wounds (Table 3).

There were a total of 20 patients (8.2%) who were multiply injured which also necessitated emergency treatment of their other conditions.

Of all these open fractures, 7 patients (2.8%) underwent a major limb amputation, 3 of which were done during the initial surgical intervention. The mechanisms of injury were as follows: four were vehicular related accidents, 2 from gun shot wounds, and 1 from a blast injury. Of these seven patients, 6 (85.7%) developed an infected open stump.

A total of 129 patients (52.7%) were either managed at the emergency room or treatment room while 116 (47.3%) were brought up to the operating room.

TABLE 2
Frequency of Open Fractures as to Type.

Type	Number	Percentage
I	113	46%
II	68	28%
III	64	26%

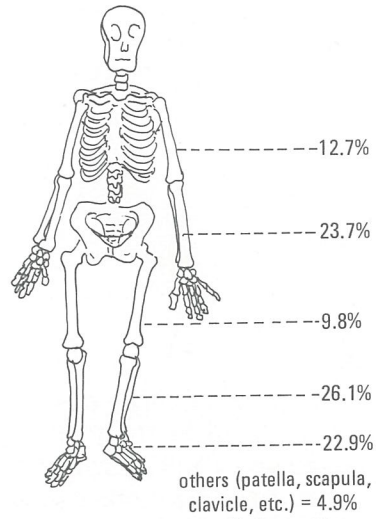

Fig. 1 Anatomic Site of Open Fractures

TABLE 3
Mechanisms of Injury.

Mechanism	No. of patients	Per cent
Gunshot wound	74	30.2
Pedestrian Accidents	49	20.0
Fall	39	15.9
Motor Vehicle Accidents	23	9.4
Hacking Injuries	20	8.2
Falling Objects	13	5.3
Mauling	10	4.1
Others	17	6.9

Most of these open fractures were initially managed during the first 8 hours of injury as seen in Table 4.

Only 17.5% underwent stabilization procedures for the fractures with the use of Steinman pins, screws, or plates at the initial debridement (Table 5).

Only a total of 133 patients (54.3%) were admitted while the rest (45.7%) were sent home after treatment and were closely followed up at the Out-Patient Department. Most of the patients (77.6%) were unable to afford the recommended course of intravenous antibiotics. The manner with which these antibiotics were administered are as follows (Table 6).

TABLE 4
Time of Initial Management.

Time	No. of patients	Per cent
< 8 hrs.	158	64.5
> 8 hrs. to < 16 hrs.	52	21.3
> 16 hrs. to < 24 hrs.	16	6.5
> 24 hours	19	7.8

TABLE 5
Stabilization Procedures.

Procedure	No. of patients	Per cent
Internal Fixation	30	12.2
External Fixation	13	5.3
None	202	82.4

TABLE 6
Manner of Antibiotics Administration.

Course	No. of patients	Per cent
3 days IV antibiotics	55	22.4
3 doses IV antibiotics then oral route	10	4.1
IV loading dose then oral	56	22.9
Oral antibiotics only	46	18.8
Irregular antibiotics	58	23.7
No antibiotics	20	8.2

TABLE 7
Average Hospital Stay.

Fracture Type	Average Hosp. Stay (days)
I	22
II	14
III	32

TABLE 8
Infection Rates.

Fracture Type	No. of patients	Per cent
I	1/113	0.88
II	7/68	10.29
III	31/64	48.44
Overall	39/245	15.9

TABLE 9
Infecting Organisms.

Organisms	No. of patients	Per cent
Pseudomonas Aeruginosa	17	43.6
Enterobacter sp.	15	38.5
Acinetobacter anitratum	5	12.8
Klebsiella sp.	4	10.3
Staphylococcus aureus	4	10.3
Escherichia coli	3	7.7
Proteus mirabilis	3	7.7
Enterococcus sp.	1	2.6
Achromobacter sp.	1	2.6
Citrobacter sp.	1	2.6
Edwardsiella tarda	1	2.6

The average hospital stay of the patients, based on fracture type were as follows (Table 7).

Of the 245 cases reviewed, a total of 39 open fractures became infected, showing an over-all infection rate of 15.9% (Table 8).

Gram negative organisms predominated as the etiologic agents in infections of open fractures (Table 9).

ANALYSIS/DISCUSSION

There are several factors that can affect the outcome of the injury. All these were statistically analyzed using the stepwise Logistic Regression Analysis. The results showed that 3 factors played a major role in the causation of infection:

1. type of open fracture;
2. presence of related injuries necessitating emergency management;
3. mechanism of injury.

The significance of the first factor is understandable since the type reflects the severity of the injury. Comparison of results with the study done at Hennepin County Medical Center showed a similar trend – an increase in infection rate with a corresponding increase in soft tissue injury (Table 10).

It must be noted that the infection rate is much higher in PGH and this can be attributed to the less than ideal conditions that have been pre-

TABLE 10
Infection Rates of Open Fractures.

Type	Hennepin County Medical Center (1976–79)	Phil. Gen. Hospital (1985–87)
I	0.00%	0.88%
II	1.81%	10.29%
III	22.90%	48.44%
Overall Rate	10.10%	15.90%
Sample Size	207	245

TABLE 11
Infection rate among the Different Mechanisms of Injury.

Mechanism	No. infected/ Total Cases	Per cent
Motor Vehicle Accident	7/23	30.4
Pedestrian Accident	14/49	28.6
Hacking Injury	3/20	15.0

TABLE 12
Protocol for Antimicrobial Coverage of Open Fractures (PGH).

Type I: Cefazolin 1 gram IV 1 hour before surgery, then 1 gram every 8 hours up to 2 days pos post-op.

Types II & III: Cefazolin, as above, and Aminoglycoside for the same duration.

In severe type III fracture, add high dose Penicillin to the regimen:

Adults: 20 million units/day in six divided doses
Children : 250,000 units/kg./day in six divided doses

In Penicillin-sensitivie patients, may give Clindamycin or Erythromycin

viously described. Considering all other factors equal, it is of interest that the risk for developing infection for types II and III are 1.04 and 17.38 times more than for type I open fractures, respectively.

Another important factor is the presence of related injuries which also required emergency treatment. This may be a vascular problem, a pneumothorax, a blunt abdominal injury, or another open fracture elsewhere. Here is the PGH, 8.2% (20 patients) of the cases were classified as multiply injured. It is of note that 45% (9 cases) ended up with an infected fracture site. This may be attributed to a delay in the treatment of the open fracture, since the life-threatening condition took precedence, in terms of management. Another possibility is that the demand on the immune mechanism of the individual is greater, leading to a relatively less efficient defense system. Statistically, patients with multiple injuries have a 2.97 times greater risk of acquiring an infection, compared to those with a simple open fracture.

Mechanism of injury constitute the third major predictor. When these specific mechanisms of injury were crosstabulated with the occurrence of infection, the highest morbidity were garnered from the following (Table 11).

Age, sex, and the anatomic site of open fractures did not affect the outcome of the injury. The factors of time of initial debridement and parenteral antibiotic administration, which are accepted determinants of injury outcome, were not found to be statistically significant.

Gram negative organisms predominated as the etiologic agents in infected cases (89.7%), whereas gram positive organisms, particularly Staphylococcus aureus and Enterococcus comprise the rest (10.3%). Anaerobic cultures were not done. Consider now the present protocol for antimicrobial coverage of open fractures (Table 12).

Cefazolin is usually the preferred first generation cephalosporin since it can be administered less frequently due to its longer half-life. It is relatively well-tolerated after intramuscular or intravenous injections (Mandell, 1985). The studies of Patzakis, et al. (1974) and Gustilo and Anderson (1976) showed a statistically significant lower infection rate among open fracture patients receiving cephalosporins in contrast to two other groups, one receiving penicillin and streptomycin, and the other receiving no antibiotics.

Among the organisms isolated, Cefazolin's spectrum covers *Staphylococcus, Klebsiella, E. coli,* and *Proteus mirabilis.* Aminoglycosides, on the other hand, are effective for all the organisms isolated (See Table 13).

It is worthwhile to note that the organisms

TABLE 13
Susceptibility Patterns of the Isolated Organisms to Cefazolin and Aminoglycosides (Mandell, 1985)

Organisms	Cefazolin	Aminoglycoside*
Pseudomonas sp.	0	+
Enterobacter sp.	0	+
Acinetobacter sp.	0	+
Staphylococcos sp.	+	+
Klebsiella sp.	+	+
Escherichia sp.	+	+
Proteus sp.	+	+
Enterococcus	0	+
Achromobacter sp.	0	+
Citrobacter sp.	0	+
Edwardsiella sp.	0	+

*—Gentamycin, Netilmicin, Tobramycin, Amikacin

covered by Cefazolin are also sensitive to aminoglycosides. Couple this with the fact that the two most frequently isolated organisms, Pseudomonas and Enterobacter, are highly sensitive to this same group of drugs. In view of these data, it is felt that the aminoglycosides may assume the role of antimicrobial of choice in the management of all types of open fractures, in contradistinction to its traditional role of being reserved only for severe cases. Since the administration of antibiotics in open fractures is therapeutic rather than prophylactic (Bergquist and Murphy. 1987), then the choice of antibiotic is crucial and must be guided by the predominant organisms isolated in the local setting.

The main drawback of the aminoglycosides is its potential for nephrotoxicity. Lietmen (1985) states that a reduction of glomerular filtration rate occurs in 5-25% of aminoglycoside recipients, which may be monitored adequately by serial serum creatinine determinations. The extent of renal damage, which is reversible, is most often mild, occasionally moderate, and is rarely severe. However, severe dysfunction may be averted by the careful adjustment of the dosage, based on the changing glomerular function.

CONCLUSION

In the Philippine General Hospital setting, where conditions are less than ideal, it has been noted that the three most important predictors of infection are: 1) type of open fracture; 2) mechanism of injury; and 3) the presence of related injuries which also necessitated emergency treatment. Gram negative organisms predominated as etiologic agents, particularly the Pseudomonas and the Enterobacter species. In view of these findings, it is suggested that aminoglycosides become the primary antibiotic administered for all types of open fracture, pending controlled clinical trials on its indications and effectiveness.

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