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Antibiotic prophylaxis in penetrating injuries of the chest

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Most prospective studies recommend antibiotic prophylaxis whilst a thoracostomy tube is in place or even longer. We conducted a randomised study of 188 patients with penetrating chest injuries requiring a chest drain. Of these patients, 95 received a single dose of ampicillin before insertion of the chest tube, the remaining 93 patients received additional antibiotic prophylaxis for as long as the drain was in place. The incidence of intrathoracic sepsis (pneumonia or empyema) was 3.1% and 3.2%, respectively. It is concluded that single-dose prophylaxis in penetrating chest trauma is as effective as prolonged prophylaxis. The importance of chest physiotherapy immediately after the drain insertion and of early removal of the drain is stressed. The role of various possible risk factors in the development of sepsis is discussed.

About 85% of patients with penetrating injuries of the chest can safely be managed non-operatively, by means of a thoracostomy tube (*1*). The role of routine antibiotic prophylaxis in this group of patients is not clear. Many existing policies are based on empirical experience rather than on scientific evidence. Very few randomised studies have been carried out in this field and all of them compared prophylactic antibiotics for as long as the tube was in place versus no antibiotics at all. The evidence is overwhelming that antibiotics are indicated. In the present study, which to our knowledge is the largest series undertaken, we compared single-dose prophylaxis versus long-term prophylaxis for as long as the drain was in place.

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Patients and methods

A randomised study was performed at Baragwanath Hospital, Johannesburg, over a period of 10 months. All patients with penetrating chest injuries requiring a thoracostomy tube were candidates for inclusion in the study. Excluded from the study were: (a) patients with significant extrathoracic injuries, (b) patients requiring an emergency thoracotomy, (c) patients with a history of penicillin allergy, and (d) violation of the protocol. The patients determined to be suitable subjects for the study were randomised to receive either a single intravenous injection of ampicillin (1 g) before thoracostomy tube insertion or a single intravenous injection of ampicillin (1 g) followed by oral ampicillin (500 mg) 6-hourly for as long as the tube remained in place.

The thoracostomy tube was inserted routinely in the mid-axillary line, above the level of the nipples. Immediately after tube insertion vigorous physiotherapy was administered by the doctor, in order to promote drainage of any haemothorax and expansion of the collapsed lung. We consider this step to be of paramount importance. The patients were assessed daily during hospitalisation and subsequently in the outpatient department after a minimum period of 10 days. Parameters specifically looked for were pneumonia,

Table I. 188 patients with chest drains

	Group A (*n* = 95)	*Group B* (*n* = 93)
Age (mean)	29.4	27
Sex	89M, 6F	86M, 7F
Weapon		
Knife	87	87
Bullet	8	6
Number of chest wounds	2.09 ± 1.75	2.04 ± 1.39
Time from injury to tube insertion (min ± SE)	156.7 ± 20	156 ± 16.4

Group A: Single-dose prophylaxis
Group B: Prophylaxis for as long as the drain remained in place

empyema, and wound infection. A pneumonia was diagnosed if there was fever or coughing of purulent sputum, and infiltrate on the chest radiograph. Empyema was diagnosed if there was purulent discharge in the thoracostomy tube or fluid collection in the pleural cavity associated with fever. The tube insertion site was considered to be infected if there was pus or significant skin erythema requiring antibiotic treatment.

Results

Patients

A total of 234 patients was included in the study. However, 46 patients were excluded from analysis because of violation of the protocol, particularly due to a follow-up shorter than 10 days. The remaining 188 patients fulfilled the criteria for analysis. A single dose of ampicillin was given to 95 patients (Group A) and 93 patients received ampicillin for as long as the chest tube was in place (Group B). The two groups were well matched with regard to age, sex, weapon of injury, time from injury to tube insertion, and radiological findings (Tables I, II).

Septic complications

The overall incidence of intrathoracic sepsis (pneumonia, empyema) was 3.2% (3.1% for group A and 3.2% for group B, $P > 0.05$). Minor sepsis at the thoracostomy tube insertion site occurred in 12 patients (6.4%) (7.4% in group A and 5.4% in Group B, $P > 0.05$) (Table III). One patient with empyema in group B required rib resection.

Table II. Radiological findings in 188 patients

	Group A (*n* = 95)	*Group B* (*n* = 93)	*Total* (*n* = 188)
Haemothorax	9	15	24 (12.8%)
Pneumothorax	28	26	54 (28.7%)
Haemopneumothorax	58	52	110 (58.5%)

Group A: Single-dose prophylaxis
Group B: Prophylaxis for as long as the drain was in place

Table III. Septic complications

	Group A (*n* = 95)	*Group B* (*n* = 93)	*Total* (*n* = 188)
Empyema	0 (0%)	1 (1.1%)	1 (0.5%)
Pneumonia	3 (3.1%)	2 (2.1%)	5 (2.7%)
Wound sepsis	7 (7.4%)	5 (5.4%)	12 (6.4%)

Non-septic complications

A total of 16 patients (8.5%) had a residual haemothorax after removal of the thoracostomy tube (7.4% in group A, 9.7% in group B, $P > 0.05$). In 13 of these patients the residual haemothorax was managed successfully with percutaneous aspiration. The remaining three (1.6%) required a minithoracotomy for clot evacuation (two patients in group A and one in group B).

Hospital stay

The hospital stay for patients not requiring an operation in group A was 2.54 ± 0.10 days (mean ± SE), and in group B it was 2.99 ± 0.14 days ($P > 0.05$). Development of intrathoracic sepsis increased hospitalisation (mean 13.5 days).

Possible risk factors for septic complications

The overall incidence of sepsis in bullet injuries was 7.1% compared with 9.2% in knife inflicted injuries ($P > 0.05$). No intrathoracic sepsis occurred in the group of patients with bullet injuries.

Haemothorax was not associated with a higher incidence of sepsis than simple pneumothorax. A total of 134 patients had a haemothorax or a haemopneumothorax, and the overall incidence of sepsis was 9.7%, compared with 7.4% in the group of 54 patients with a pneumothorax only ($P > 0.05$). Similarly, the incidence of intrathoracic sepsis was 3.7% in patients with free blood in the chest and 1.8% in patients with a pneumothorax only ($P > 0.05$). However, in the 16 patients who had a residual haemothorax after drain removal, the incidence of empyema was 6.2% compared with no case of empyema in the rest of the patients ($P < 0.01$).

Discussion

The role of antibiotics in preventing thoracic sepsis after penetrating chest injuries has been under-investigated. Very few randomised studies have been published (2–7). All existing prospective studies include relatively small numbers of patients (Table IV), and most of them do not

differentiate between penetrating trauma, blunt trauma, and even spontaneous pneumothorax (*2,4,6,7*). All studies compared no antibiotic prophylaxis with antibiotic prophylaxis for the duration the chest drains remained in place or longer. Of the existing prospective studies, four strongly supported antibiotic prophylaxis (*3,4,6,7*). Only two studies expressed doubts about the role of antibiotics (*2,5*). LeBlanc and Tucker (*2*), in a study of 85 patients which included blunt trauma, penetrating trauma, and spontaneous pneumothorax, reported an incidence of sepsis of 10.8% in the no-antibiotics group and 2.6% in the antibiotics group. Although these figures failed to reach statistical significance, the conclusion of the authors that "antibiotics are of no definitely proved benefit" was not justified, especially when one takes into account the small, mixed series. The second study which concluded against routine antibiotic prophylaxis is by Mandal *et al.* (*5*), who reported an incidence of septic complications of 2.5% in the no-antibiotics group and 0% for the antibiotics group. Collectively, in six prospective studies with 508 patients, the overall incidence of sepsis was 13.3% for those not receiving antibiotics and 1.6% for those receiving antibiotics. This difference is highly significant ($P<0.01$).

The above studies show convincingly that antibiotics do have a role to play in the management of patients with chest drains. However, the duration of antibiotic prophylaxis remains empirical. All existing studies used antibiotics for as long as the thoracostomy tube was in place (*5,6*) or for 24–48 h after the removal of the tubes (*2,7*) or a minimum of 5 days (*3*). The duration of chest intubation in these studies varied from 4–7 days on average. No study prior to this one has investigated the role of single-dose prophylaxis.

Table IV. Antibiotic prophylaxis in available prospective studies

Ref.	*No of patients*	*Indication for drain*	*Antibiotic regimen*	*Intrathoracic sepsis*	
2	85	Blunt trauma Penetrating trauma Spontaneous pneumothorax	No antibiotic *vs* Cephapirin (until 24 h after removal of drain)	4.3% *vs* 2.6%	NS
3	75	Penetrating trauma	No antibiotic *vs* Clindamycin (until 24 h after removal of drain)	51.3% *vs* 13.1%	$P<0.01$
4	58	Blunt trauma Penetrating trauma	No antibiotics *vs* Cefoxitin (until 12 h after removal of drain)	29% *vs* 3%	$P<0.05$
5	80	Penetrating trauma	No antibiotics *vs* Doxycycline (until removal of drain)	2.5% *vs* 0	NS
6	90	Blunt trauma Penetrating trauma	No antibiotics *vs* Cephazolin (until removal of drain)	13% *vs* 0	$P<0.05$
7	120	Blunt trauma Penetrating trauma	No antibiotics *vs* Cephamandole (until 48 h after removal of drain)	13.3% *vs* 1.7%	$P<0.01$
Present Study	188	Penetrating trauma	Ampicillin single dose *vs* Ampicillin until drain removal	3.1% *vs* 3.2%	NS

NS = Not significant

This study has clearly demonstrated that single-dose prophylaxis was as effective as prolonged antibiotic prophylaxis. These findings are in line with recent studies in penetrating abdominal trauma, which suggested that there is no need for prophylaxis longer than 12 h postoperatively *(8)*.

We believe that the most important factor in preventing intrathoracic septic complications, is intensive chest physiotherapy immediately after insertion of the tube. This encourages better drainage and early expansion of the lung, thus decreasing the chances of pneumonia and empyema. Furthermore, early intensive physiotherapy and evacuation of the free blood before clotting occurs, decreases the need for thoracotomy and pleural toilet. Our incidence of pleural toilet was only 1.6%. A second important factor in the prevention of sepsis is removal of the drain as soon as possible. In the vast majority of patients this can be achieved within 2–3 days. Eddy *et al. (9)* found the incidence of empyema increased in patients with incompletely drained pleural cavities and in patients with chest drains in place for a prolonged period.

The presence of a haemothorax was not associated with an increased incidence of intrathoracic sepsis when compared to isolated pneumothoraces (3.7% *vs* 1.8%, $P > 0.05$), provided the haemothorax was drained adequately. Incomplete draining of the free intrathoracic blood due to clotting, predisposes to empyema, especially if the thoracostomy tube remains in place for a long time. Our incidence of empyema in patients with residual haemothorax was 6.2% compared with no empyema in the rest of the patients ($P < 0.01$). Similar conclusions were reported by Eddy *et al. (9)*. The thoracostomy drain should be removed as soon as it stops draining, even if the chest radiograph shows residual haemothorax. A second attempt should be made to drain the remaining blood percutaneously, and if this fails the next step is a thoracotomy and pleural toilet, ideally within 3–5 days of admission, before the clot becomes organised.

Bullet injuries were not associated with a higher incidence of intrathoracic sepsis. There was no case with intrathoracic sepsis in the 14 patients with bullet wounds. However, it must be emphasised and these were low-velocity missiles. There is no doubt that high-velocity injuries are associated with increased sepsis.

In conclusion, we have shown that single-dose antibiotic prophylaxis in penetrating chest trauma is as effective as prolonged prophylaxis. Early physiotherapy and early removal of the thoracostomy tube are important in preventing intrathoracic sepsis.

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