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Prophylaxis of postpneumonectomy empyema

P GOLDSTRAW

From the Department of Thoracic Surgery, Wentworth and King George V Hospitals, Durban, South Africa

ABSTRACT Systemic antibiotics started before operation have been found to give inadequate prophylaxis against postpneumonectomy empyema in our practice. Experimental work by others has suggested that combining this treatment with topical irrigation and intrapleural antibiotics would give improved results. We have adopted this suggestion and found it to give better prophylaxis where pneumonectomy is associated with high risk factors. The difficulty of anticipating these high risk cases, and fringe benefits of this combined technique, make this brief addition to operating routine reasonable in all cases.

The incidence of postpneumonectomy empyema varies from 2.2% to 16% in reported series (table 1). This variation may reflect technical differences between groups of surgeons, but no details are given to help guide surgical practice. Preoperative preparation with physiotherapy and by cessation of smoking is reasonable but has not been shown to affect operative morbidity. The incidence of empyema is similar after pneumonectomy for neoplasm and inflammatory disease.[4 6] Prophylactic antibiotics may be useful but are often haphazardly applied, orally, systemically and locally, in many combinations. Experimental work is lacking but the study of Bhayana *et al*[7] gives some guidance as to how prophylactic antibiotics may best be used. These researchers produced standard pus by leaving an infarcted lobe in the thorax of a dog. Eighty ml of this pus left in the pleural space after lobectomy was found to produce an empyema in 100% of dogs. The survival of these animals was studied in five groups, each containing 10 animals (table 2). The control group had lobectomy and then 80 ml of pus was left in the chest for five minutes before closure with drainage. All these animals died within three days with gross pleural sepsis. Various therapeutic regimes were then added to this basic model, each effecting an improvement in length and number of survivals. Irrigating the pleural space with saline before closure decreased mortality to 80% and extended survival to between five and eight days. Topical antibiotics in combination with irrigation reduced mortality to 30%. When systemic antibiotics started before operation were added, sepsis was eliminated. All dogs surviving 30 days were killed, and in all groups these animals were found to be free of empyema. Bryant *et al*[8] applied these guidelines to the clinical problem. In two successive years their wound complication rate fell from 18.4% to 4·8% by using a combination of systemic antibiotics started before operation and topical

Table 1 *Reported incidence of postpneumonectomy empyema*

Author	*Number of pneumonectomies*	*Empyema*		*Pathology*
		Number	*Incidence*	
Ruckdeschel *et al*[1]	289	15	5%	Ca bronchus
Cady and Clifton[2]	252	35	14%	Ca bronchus
Takita[3]	102	9	8·8%	Ca bronchus
le Roux[4]	949	21	2·2%	Ca bronchus
	75	2	2·7%	Bronchiectasis
Kärkölä *et al*[5]	175	7	4%	Ca bronchus
Goldstraw[6]	186	30	16%	Ca bronchus
	25	4	16%	Inflammatory disease

Table 2 *Prophylaxis against induced empyema in the dog (after Bhayana et al*[7]*)*

Group	*Treatment schedule*	*Mortality*	*Interval to death (days)*
I	Control	100%	2-3
II	Saline irrigation before closure	80%	5-8
III	Saline irrigation plus topical antibiotics	30%	5-8
IV	Topical plus systemic antibiotics	20%	5-7
V	Saline irrigation plus topical and systemic antibiotics	0%	—

Addres for reprint requests: Brompton Hospital, Fulham Road, London SW3 6HP.

irrigation of the wound and pleura with saline and antibiotics at certain stages during the operation. These workers were concerned principally with wound infection and pneumonectomy cases formed only 7-8% of their study. Cooper[9] has found a significant reduction in the incidence of postpneumonectomy empyema when systemic antibiotics were used.

In Southern Africa many adverse factors combine to present the thoracic surgeon with difficulties no longer encountered in the western world. These factors affect the host, his capacity to withstand disease and surgery, and the disease processes. The host is usually malnourished and anaemic, and often has frank vitamin deficiency. He frequently has impaired liver function as a consequence of dietary inadequacies and alcohol abuse, and smokes, often heavily, coarse local tobaccos. He has impaired haemostatic mechanisms consequent on his liver dysfunction and the short-term effects of antituberculous drugs. He is chronically ill, with advanced dental caries and a multitude of parasitic infestations. His diseases are multiple, advanced, and of long standing, resulting from the ravages of tuberculosis and secondary infection. This chronic lung destruction causes total obliteration of the pleural space and a penetrating inflammatory response which involves the chest wall in a malignant manner. Mobilisation of the lung is extremely difficult, especially over apex and diaphragm, and is associated with blood loss far greater than that which is experienced when performing extrapleural mobilisation in a Caucasian patient. Excision with diathermy is routine, but this is limited by the recesses of a rigid chest wall. It is not surprising, therefore, that the morbidity and mortality of pneumonectomy in these circumstances is high. Le Roux[10] has commented that "pulmonary resection carries with it an almost prohibitively high rate of postoperative complications." In one study[11] the incidence of postpneumonectomy empyema in these patients was 24% of survivors. Plainly this level of infection is intolerable and these cases form a severe clinical model on which to test the lessons of Bhayana *et al.*[7]

Patients and methods

Between 1 January 1973 and 31 May 1978, 172 patients underwent pneumonectomy at King George V Hospital, Durban. They were allocated to two groups of surgeons using different prophylactic regimes against postpneumonectomy empyema. During the first four and a half years of this study all the patients entered group A but later a different prophylactic regimen was introduced (group B), and during the last nine months of the study the majority of patients entered this group—a few still entering group A. Group A was therefore larger (143 cases) than group B (29 cases).

In group A, 129 patients were given prophylactic cephalothin sodium (Keflin—Lilly), 4-8 g daily by intermittent intravenous infusion for one to five days (mean 2·3 days) before operation. In the remaining 14 this was omitted, either because they were uncomplicated tumour cases (13 patients), or in one case because the operation was an emergency. In all young children, oral cephalex (Keflex—Lilly) was administered for a similar preoperative period. In all patients the antibiotic was continued after operation, usually by intravenous infusion, until 24 hours after removal of the drain and thereafter orally at the discretion of the surgeon.

Group B patients were given the same systemic antibiotic regime for one to three days (mean 2·1 days) before operation. The antibiotic was omitted in five patients with uncomplicated neoplasms and two patients undergoing emergency pneumonectomy. Postoperative antibiotics were given as in group A. In addition, these 29 patients all had irrigation of their pneumonectomy space and wound margins with a litre of saline immediately before chest closure, and 2 g of chloramphenicol powder (Chloromycetin—Parke-Davis) was sprinkled into the space and onto the wound margins at closure. In children, the dose of topical antibiotic was reduced in keeping with their mass.

Table 3 contains a summary of the incidence of some preoperative factors in groups A and B. The two groups can be seen to be similar. Africans predominated, forming 96·5% of group A and 100% of group B. The remaining patients in group A were Asian. Eleven patients in group A (7·7%) and three (10·3%) in group B underwent urgent or emergency surgery. In group A

Table 3 *Preoperative state of patients in study*

	Group A	*Group B*
Total in study	143	29
Male sex	82 (57·3%)	16 (55·2%)
Ethnic group African	138 (96·5%)	29 (100%)
Asian	5 (3·5%)	
Preoperative empyema	24 (16·8%)	4 (13·8%)
Emergency or urgent surgery	11 (7·7%)	3 (10·3%)
Disease Inflammatory	130 (90·9%)	24 (82·8%)
Neoplastic	13 (9·1%)	5 (17·2%)
Preoperative Keflin (days, mean)	2·3	2·1

13 (9·1%) pneumonectomies were for neoplasm and 130 (90·9%) for lungs destroyed by chronic destructive pneumonia, bronchiectasis, and tuberculosis in many combinations. In group B, five (17·2%) resections were for neoplasms and 24 (82·8%) for infective conditions. The earlier, overlapping study of Odell and Henderson[11] had identified factors which resulted in a marked increase in the incidence of postpneumonectomy empyema. These high risk factors were a pneumonectomy performed across an empyema cavity, and troublesome bleeding requiring reopening of the chest or the extreme measure of temporary packing of the chest with swabs. The incidence of preoperative empyema and the occasional extreme measure of temporary packing of the chest to control haemorrhage was not dissimilar in groups A and B. In group A, 13 patients (9·1%) were reoperated on for haemorrhage, whereas in group B eight (27·6%) required this measure. This difference resulted in a higher incidence of high risk cases in group B (44·8%) than in group A (31·5%).

The method of bronchial closure differed in the two groups. In group A, the bronchus was transected at the carina and the open bronchus closed with interrupted sutures of silk in all cases but one, where interrupted prolene was used. In group B, four patients had this type of closure but the majority had closure by a closed method, crushing the bronchus flush with the carina, excising the lung and suturing proximal to the crushing clamp with a to and fro suture of 2/0 prolene. After the excess of bronchial cuff had been trimmed, the clamp was removed and the suture tied with sufficient tension to prevent air leak. Closure was then completed by an over and over suture of 2/0 prolene along the crushed flange. The theoretical advantages of this method were largely negated by the routine use of a double lumen tracheobronchial tube in both groups.

The operative blood loss, expressed as a percentage of the estimated total blood volume,[12] reached levels incomprehensible to any surgeon who has not struggled to remove one of these lungs. For group A, recorded operative loss ranged from 3-368% (mean 70%) of estimated total blood volume, and for group B from 7-193% (mean 51·9%). The pneumonectomy space was drained in 91·5% of group A and in 92% of group B patients, the drain being removed between the first and fourth postoperative days (mean 1·3 days) in the former, and between the first and fifth postoperative days (mean 1·4 days) in the latter. Bleeding necessitated reopening of the thoractomy in 13 patients (9·1%) from group A and in eight (27·6%) from group B, and was sufficiently troublesome to require temporary packing of the chest in 13 patients (9·1%) in group A and one (3·4% in group B. The operative mortality (up to 30 days) of the two groups was similar. There were nine perioperative deaths (6·3%) in group A and three (10·3%) in group B. High risk factors—the presence of preoperative empyema, reoperations for haemorrhage, or packing for uncontrollable parietal bleeding—operated in 45 (31·5%) of group A patients and in 13 (44·8%) of those in group B.

The two groups were thus comparable for the preoperative factors considered in table 3, and for the operative features with the exception of the method of bronchial closure and the higher incidence of reoperation in group B (table 4).

Table 4 *Perioperative morbidity of study groups*

	Group A (*n*=143)	*Group B* (*n*=29)
Preoperative empyema	24 (16·8%)	4 (13·8%)
Packed at operation	13 (9·1%)	1 (3·4%)
Reopened for haemorrhage	13 (9·1%)	8 (27·6%)
High risk cases	45 (31·5%)	13 (44·8%)
Operative blood loss (mean % volume)	70	51·9
Operative mortality (30 days)	9 (6·3%)	3 (10·3%)
Days of drainage (mean)	1·3	1·4

Results

Only patients surviving operation to leave hospital or develop an empyema were included in the results (table 5).

In group A, 34 of 133 patients who qualified for analysis developed postpneumonectomy empyema (25·6%), compared with two of 26 patients in group B (7·7%).

Patients who survived pneumonectomy in the presence of one or more high risk factors were considered separately. Of these patients, 19 of 40 (47·5%) in group A, and one of 12 (8·3%) in group B developed postpneumonectomy empye-

Table 5 *Incidence of postpneumonectomy empyema in study groups*

	Group A	*Group B*	
Overall	34/133 (25·6%)	2/26 (7·7%)	$p<0.05$
Preoperative empyema	12/22 (54·5%)	1/4 (25%)	NS
Reopened for haemorrhage	5/12 (41.7%)	0/7 (0%)	NS
Packed for haemorrhage	6/10 (60%)	0/1 (0%)	NS
High risk factors present	19/40 (47·5%)	1/12 (8·3%)	$p<0.05$
High risk factors absent	15/93 (16·1%)	1/14 (7·1%)	NS

Denominator in all cases is number available for study
NS=not statistically significant

ma. Consideration of each of these high risk factors individually resulted in very small numbers, about which no comment can be made. Of 22 patients in group A and four in group B who survived pneumonectomy across an empyema cavity, 12 (54·5%) and one (25%) developed postoperative empyema. Twelve patients in group A and seven in group B survived pneumonectomy and subsequent reoperation for continued haemorrhage, and five (41·7%) of group A and none of those in group B developed empyema. Packing of the chest to control haemorrhage was survived by 10 patients in group A, of whom six (60%) developed an empyema. This measure was resorted to in only one patient in group B and she survived without overt space infection.

In the absence of any of these high-risk factors, 15 patients from 93 survivors in group A (16·1%) and one from 14 (7·1%) in group B developed postpneumonectomy empyema.

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Discussion

Pneumonectomy in these patients is a formidable undertaking attended by great technical difficulties, considerable blood loss, and appreciable mortality. The morbidity of postpneumonectomy empyema is high but seems amenable to prophylaxis. A combination of topical irrigation together with systemic and topical antibiotics gave a lower incidence of this complication than systemic antibiotics alone. This difference was marked overall, and especially in the subgroup where high risk factors were operating. In the absence of these high risk factors, the effectiveness of the two prophylactic regimes was probably similar. In interpreting these results, however, it should be remembered that the groups were not randomly allocated and that the method of bronchial closure was different in the two groups.

Topical irrigation adds but a minute to the operation and, in addition to the mechanical cleansing of the pneumonectomy space, affords an excellent opportunity to test the competence of bronchial closure and to apply local cytotoxic agents. Sterile water is a cheap, readily available cytotoxic agent and it would seem reasonable to use it for irrigation after pneumonectomy for tumour. Irrigation often highlights bleeding points, making haemostasis more effective. The addition of topical chloramphenicol did not lead to any local or systemic complications in this study.

Troublesome postoperative bleeding is always unexpected, since no surgeon would close the chest if bleeding was still excessive. In view of this, and the fringe benefits of irrigation, it would seem reasonable to apply this prophylactic regime to all cases coming to pneumonectomy. Controlled studies using standardised methods of bronchial closure are necessary to confirm our early encouraging results.

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