EFFICACY AND COST-EFFECTIVENESS OF BRONCHIAL ARTERIAL EMBOLISATION IN THE TREATMENT OF MAJOR HAEMOPTYSIS

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Objective. To determine the efficacy and cost-effectiveness of bronchial artery embolisation (BAE) in the treatment of major and massive haemoptysis in HIV-positive and negative patients with pulmonary inflammatory disease.

Methods. A retrospective review of patients admitted over a period of 24 months to Wentworth Hospital with major haemoptysis treated using BAE.

Results. Eighty-seven patients were treated (77 males, 10 females). Bilateral disease was present in 50 patients (57%). Thirty-two patients were HIV-positive (37%). Embolisation was successfully performed in 77 patients (88.5%), and failed for technical reasons in 10 patients (11.5%). There was only one procedural complication. Fifty-seven patients had a successful outcome, with cessation of haemoptysis within 24 hours (66.5%). Haemoptysis continued in 30 patients (34%) (20 patients embolised and the 10 patients who had failed procedures). Fourteen of these patients (16%) required lobectomy or pneumonectomy as an emergency procedure. Five patients (5.7%) died from respiratory failure or pulmonary haemorrhage. Twenty-four HIV-positive patients were successfully embolised. Costing of BAE, including a 2-day ICU and 3-day ward stay, was R6 720; together with surgical resection the cost was R14 170.

Conclusions. BAE is an effective treatment for major and/or massive haemoptysis in patients with pulmonary inflammatory disease who are not surgical candidates. Patients who are HIV-positive are able to tolerate the procedure well.

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Massive haemoptysis is defined as blood loss exceeding 600 ml over 24 hours or haemoptysis exceeding 250 ml in one episode, and sufficiently severe to require admission to an intensive care unit (ICU). Untreated massive haemoptysis has a mortality rate exceeding 50%.[1] Major haemoptysis includes massive haemoptysis and those patients with ongoing haemoptysis considered at risk of life-threatening haemoptysis. Bronchial arterial embolisation (BAE) has become the treatment of choice to stabilise the patient before surgical resection of the bleeding region.[2] Embolisation is also used as a definitive treatment in those patients who are not surgical candidates.[3] BAE is effective in stopping haemoptysis in 75 - 90% of patients.[4]

We have used BAE at Wentworth Hospital, Durban, to treat haemoptysis from inflammatory lung disease. The spectrum of patients has changed over the last 5 years with the rapid increase in the incidence of PTB associated with HIV infection in KwaZulu-Natal.[5]

The purpose of this study was to determine the efficacy and cost-effectiveness of BAE in the treatment of massive haemoptysis in pulmonary inflammatory disease patients with and without HIV infection.

METHODS

We retrospectively reviewed the case notes, chest radiographs, computed tomography (CT) scans and bronchial angiograms of all patients who had BAE performed at Wentworth Hospital, a 400-bed tertiary referral centre for cardiothoracic disease, from January 1997 to December 1998. Wentworth Hospital is the only referral centre for cardiothoracic patients in KwaZulu-Natal, which has an estimated population of 8.5 million people. We recorded the following data: demographic information, length of hospital stay, aetiology of infection or pulmonary pathology, extent of disease on chest radiograph and/or CT of the lungs, HIV status, surgical procedures, and outcome. Outcome was considered successful if the haemoptysis stopped or markedly decreased within 24 hours of the procedure. The procedure was considered a failure if the haemoptysis continued after 24 hours or if an emergency surgical lung resection had to be performed.

We determined the direct costs of the hospital stay including intensive care, the cost of investigations such as the full blood count, sputum analysis, bronchoscopy, CT of the lungs, the cost of the embolisation procedure, the cost of drugs and blood products given during the hospital stay and the cost of surgical procedures. HIV testing was carried out with the full informed consent of the patient. All patients underwent bronchial arteriography followed by embolisation. The decision to perform embolisation was made by the cardiothoracic surgeon (DB) on the basis of massive haemoptysis, i.e. more than 600 ml of blood over 24 hours (5 cupfuls), or the presence of ongoing haemoptysis in the presence of active tuberculosis or

non-resectable pulmonary disease. Pulmonary disease was assessed as not surgically treatable if the patient had poor pulmonary function or when high-resolution CT (HRCT) confirmed bilateral and extensive disease. HRCT was performed on all patients except those few who had respiratory failure and extensive bilateral disease and who were too dyspnoeic to lie supine in the scanner. HRCT was used to identify areas of bleeding. If bronchial embolisation was not technically possible or if it failed, emergency pulmonary resection of the affected lung was performed if feasible.

We performed the bronchial arteriograms with digital subtraction angiography (Toshiba, Japan) using a standard technique of femoral arterial puncture and selective catheterisation of the bronchia and internal thoracic arteries bilaterally.[6] The technique was performed by three authors (PC, CS, DR) as well as a number of registrars undergoing training who were supervised by the authors. Selective catheterisation of the internal thoracic arteries is important. Pleural involvement due to chronic tuberculosis commonly recruits collateral feeders from these arteries. The bronchial and internal thoracic arteries were embolised routinely if there was evidence of a vascular blush on contrast injection or if the arteries were hypertrophied. The end points of pulmonary vascular blush and arterial hypertrophy were easy to identify and there was no inter-observer variation in the detection of these end points between authors. We embolised all regions of the lungs that demonstrated hypervascularity after contrast injection. We did not embolise the artery if there was a contribution to the anterior spinal artery. We used polyvinyl particles, 500 - 750 microns in diameter, suspended in contrast (Contour, Nycomed, Paris, France and Trufill, Cordis, USA) as the embolic agent of choice.

Table I. Aetiology of pulmonary disease

Aetiology	Number	Percentage
Active PTB (AFB-positive) (3 MDR-TB)	50	57.5
Bronchiectasis	31	35.6
Mycetomas	4	4.6
Neoplasms	2	2.3

AFB = acid-fast bacillus; MDR = multidrug resistant TB.

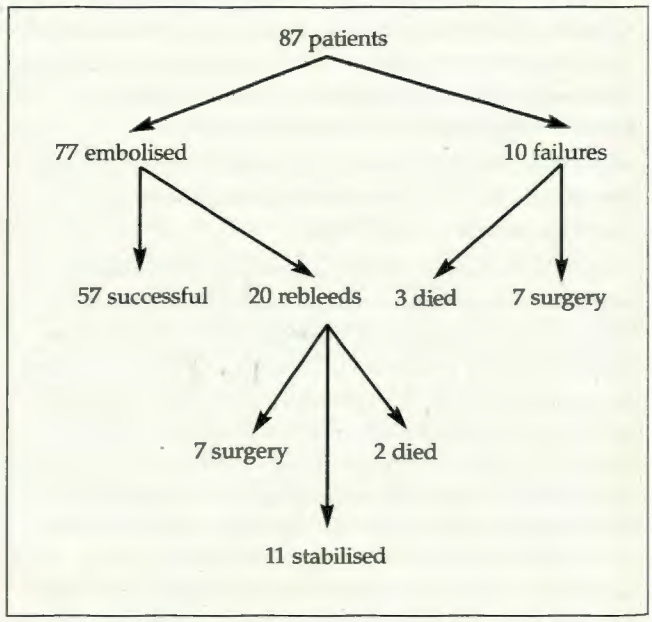

Fig. 1. Patients' immediate outcome.

RESULTS

Eighty-seven patients were identified who had had bronchial embolisation over the 24-month period. There were 77 male and 10 female patients, with a mean age of 38 years (standard deviation (SD) 12.5). The aetiology of the pulmonary disease is recorded in Table I. In 50 patients (57%) the disease process involved both lungs. Thirty-two patients (37%) were seropositive for HIV, with 10 patients positive in 1997 and 22 patients positive in 1998. CD4 counts were not available for most patients because of the cost.

Embolisation was successful in 77 patients (88.5%) (Fig. 1). Embolisation could not be performed in 10 patients (11.5%) because of technical reasons, usually due to the bronchial arteries being too small for selective catheterisation. The embolisation procedure took between 30 and 60 minutes, with a mean of 45 minutes, depending on the level of expertise of the radiologist and the difficulty of selectively catheterising the bronchial arteries. There was one procedure-related complication. This was an intimal flap which was raised at the femoral artery puncture site of one patient resulting in temporary cessation of blood flow to the leg, but this resolved completely within 24 hours.

Fifty-seven patients (65.5%) had a successful outcome, with haemoptysis resolving or being markedly reduced within 24 hours. Thirty patients (34%) continued to bleed. Twenty of these patients were from the embolised group and 10 were from the group in which embolisation failed for technical reasons. Fourteen patients (16%) who continued to bleed after 24 hours required emergency lobectomy or pneumonectomy. Sixteen patients were not offered any surgical procedure; 5 of these patients (5.7%) died, while 11 stabilised. The deaths occurred mainly within 48 hours of respiratory failure and/or pulmonary haemorrhage. Of the 32 patients who were seropositive for HIV, 24 (75%) were successfully treated using embolisation, 7 had persistent haemoptysis and 1 died.

The mean hospital stay for patients who were not undergoing surgery was 5 days. Patients were followed up at the thoracic clinic, usually within 2 weeks, and only 12 patients (14%) were followed up for 1 month after the procedure. At the

Table II. Costing

	Cost (R)	Total cost of stay (R)
Hospitalisation		
Ward bed	400/day × 2 days	800
ICU bed	800/day × 3 days	2 400
Total		3 200
Medical treatment		
Drugs	100	500
Blood	350 per unit	1 050
Total		1 550
Investigations		
Full blood count	50	
Sputum AFB culture	50	
Lung function test	20	
HIV test	20	
Total	140	
Imaging		
CT lungs	500	
Chest radiograph	80	
Total	580	
Embolisation		
Bronchial angiogram	500	
Embolic materials	750	
Total	1 250	
Surgery		
Lobectomy/ pneumonectomy	5 000	
Anaesthetics	250	
Blood	700	
Bronchoscopy	500	
Total	6 450	

AFB = acid-fast bacillus.

follow-up clinic 32 of the 57 patients (56%) who were embolised successfully were reviewed. Haemoptysis had stopped completely in 20 patients and was reduced considerably in 12.

The costing of the procedure, surgical operations, hospitalisation, drugs and blood products are recorded in Table II. Professional fees were included in procedural costs. Total costs for the embolisation procedure were R6 720 per hospital stay, with a mean of 2 days in the ICU, compared with the cost of surgical resection at R12 920. If surgery was performed after failed embolisation the cost increased to R14 170 per stay.

Discussion

BAE is an effective treatment for major (including massive) haemoptysis. In almost two-thirds of our patients haemoptysis stopped or was markedly reduced by this procedure. These results are similar to those of other large series.[4,6,7] Over half of our patients had active PTB, their sputum being positive for acid-fast bacilli, with the other one-third of the patients suffering from chronic bronchiectasis. The number of patients who were seropositive for HIV doubled over the 2 years of this study, from 10 patients in 1997 to 22 patients in 1998. The fact that patients were seropositive for HIV and had PTB did not appear to affect the outcome of embolisation. There is no doubt that patients who are HIV-positive derive the same benefit from this procedure as HIV-negative patients. This procedure may be both life-saving and cost-effective. The true prevalence of HIV seroconversion in our patient cohort is not known as HIV testing can only be performed with the patient's written permission. It would be of interest to correlate outcome with CD4 counts to gauge the effect of immunodepression on the procedural outcome. We do not know the long-term outcome of our patients — many patients were lost to follow-up as they came from rural hospitals. Twenty-nine per cent of patients continued to experience ongoing haemoptysis immediately after embolisation. Patients with chronic pulmonary inflammatory disease, especially chronic TB, develop hypervascular collaterals from the internal mammary arteries, subclavian artery branches, intercostal arteries and even aneurysms from the pulmonary arteries. Unless all these collaterals are identified before embolisation, rebleeding is likely. This may make the procedure time-consuming, especially if the radiologist does not have experience in selective angiography. Bronchial anatomy is highly variable and angiographers have to be aware of the common normal variants, especially ectopic bronchial arteries which can occur in 10% of patients, usually from the apex of the aortic arch.[8,9]

The complications of BAE are well recorded in the literature.[4,7] BAE is a safe procedure in experienced hands. The most serious complication is spinal cord ischaemia caused by inadvertent embolisation of the radiculomedullary and radiculopial branches arising from the intercostal and bronchial arteries. In this series such feeders to the spinal cord were only encountered in one patient, so precluding embolisation.

Embolisation is a cost-effective procedure in the short term compared with lobectomy or pneumonectomy. However, to be used effectively radiologists must be trained in this interventional technique, have good angiography facilities and use the correct embolic materials. We have found BAE to be a safe, effective and cost-effective procedure in those patients with severe haemoptysis caused by acute and chronic pulmonary inflammatory disease. Patients who are HIV-positive appear to tolerate the procedure as well as HIV-negative patients, and show a similar response to embolisation. We would encourage the use of BAE in those patients who are not surgical candidates, and believe that more radiologists in southern Africa should learn this procedure and become comfortable in performing BAE as an emergency procedure.

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A NEW COMBINED DTP-HBV-HIB VACCINE — STRATEGY FOR INCORPORATION OF HIB VACCINATION INTO CHILDHOOD IMMUNISATION PROGRAMMES

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Objectives. To evaluate the immunogenicity and reactogenicity of a pentavalent vaccine prepared by extemporaneously mixing diphtheria-tetanus pertussis-hepatitis B vaccine (DTP-HBV) and lyophilised *Haemophilus influenzae* type B (Hib)-tetanus conjugate vaccines in the same syringe, compared with the same vaccines given as separate, concomitant administrations.

Design. Open, randomised comparative study.

Setting. Durban, South Africa.

Subjects. A total of 120 healthy male and female infants were enrolled in the trial and randomised into two groups; group 1 received the combined administration (DTP-HBV-Hib), and group 2 received separate administrations of DTP-HBV and Hib vaccines. Vaccines were given as a three-dose primary vaccination course at 6,10 and 14 weeks of age.

Outcome measures. Antibody levels were measured using standard techniques and local and general solicited symptoms were recorded using diary cards.

Results. All subjects had seroprotective titres against diphtheria and tetanus; and antipolyribose-ribitol phosphate (PRP) titres ≥ 0.15 µg/ml 1 month after the final dose. A vaccine response (defined as post-vaccination titres ≥ 15 ELISA (EL).U/ml in initially seronegative subjects; and as post- vaccination titres ≥ pre-vaccination titres in initially seropositive subjects) against the pertussis component was seen in 83% and 85% of subjects in the groups receiving combined and separate administration. No differences were

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