

Clinical and radiographic spectrum of septic pulmonary embolism

K S Wong, T Y Lin, Y C Huang, S H Hsia, P H Yang, S M Chu

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See end of article for authors' affiliations

Correspondence to:
Dr Kin-sun Wong, Division
of Pediatric Pulmonology,
Department of Pediatrics,
5 Fu Hsin Street, Taoyuan,
Taiwan;
pchest@adm.cgmh.org.tw

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Aims: To review the clinical presentation, radiographic findings, and outcome of therapy in children with septic pulmonary embolism.

Methods: Retrospective analysis of patients in a tertiary paediatric facility in northern Taiwan.

Results: Ten children were identified with septic pulmonary emboli in a four year retrospective chart review between 1998 and 2001. Seven were immunocompetent, two were premature infants, one had β thalassemia major. Seven had community acquired staphylococcal infections and bacteraemia, of which six were methicillin resistant *Staphylococcus aureus* (MRSA) isolates. Five had soft tissue infections, two bone infections, one suppurative otitis media, one catheter related infection, and one unknown foci of infection. Multiple and bilateral nodular pulmonary parenchymal lesions were common on plain chest radiographs, but chest computed tomography scans showed the additional findings of a "vessel sign" and central cavitations, confirming the existence of septic pulmonary embolism.

Conclusions: Community acquired MRSA infections occurred in seven patients with septic pulmonary embolism but without predisposing high risk factors. Critically ill children with skin, soft tissue, or bone infections, when associated with septic pulmonary embolism in an area with a high rate of MRSA, should be empirically treated with glycopeptides (such as vancomycin or teicoplanin) before susceptibility results are known, in order to minimise morbidity and avoid mortality.

Septic pulmonary embolism (PE) typically presents with fever, cough, and haemoptysis.¹⁻⁴ The most common radiographic findings of septic PE are the presence of bilateral multiple cavitory nodules in the lung periphery.⁵⁻⁷ In adult patients, the septic emboli are frequent complications of right sided bacterial endocarditis, septic thrombophlebitis, or occasionally osteomyelitis.^{1-3, 8} Septic PE is a diagnosis seldom considered in children, and reported experience of septic PE is mostly anecdotal.⁹⁻¹³ The two most recent series of septic PE in children identified from a literature search were published in the 1970s.^{14, 15} The purpose of this report is to review the clinical manifestations and radiographic abnormalities of 10 children identified in a tertiary children hospital in northern Taiwan over a four year period.

METHODS

A computer search for a discharge diagnosis of pulmonary embolism, lung cyst, lung abscess, necrotising pneumonitis, soft tissue infections (such as cellulitis, deep sited abscesses), or bone or joint infections below 18 years of age hospitalised at Chang Gung Children's Hospital (CGCH) from January 1998 to December 2001 was conducted. CGCH serves both as a primary care facility and a tertiary paediatric referral centre with a surrounding population of over 2 million and 10 000 admissions annually in northern Taiwan.

Ten patients were identified. The chest radiographs and available computed tomography (CT) scans were evaluated for the presence of pulmonary infiltrates (with or without cavitations), multiple peripheral located nodules, adenopathy, pneumothorax, or empyema. Details of patient demographics, diagnoses, antibiotic regimens, isolated organisms from blood or infectious foci, drug susceptibility, and outcome of therapy were recorded and analysed. Risk factors identified included underlying chronic disease, residence in a long term care facility, child day care centre attendance, recent hospitalisation or surgery in the past six months, presence of

an indwelling catheter, or previous antibiotic use. Septic PE was defined as the presence of lung abscess, multiple round or wedge shaped densities located in the lung periphery with or without the presence of feeding vessels, in addition to the isolation of bacteria in the blood or sites of infection during acute episodes. Each episode was classified as either community or hospital acquired according to the guidelines from the Centers for Disease Control and Prevention: nosocomial infection was defined by an isolate either from the blood or infectious site obtained at least 48 hours after hospital admission, whereas community acquired infection was defined by the isolation of organisms within 48 hours of hospital admission.¹⁶

RESULTS

Clinical findings

There were four male and six female patients (age range 12 days to 16 years). Table 1 shows the clinical features of 10 children with a clinical diagnosis of septic PE. Six patients presented with fever, tachypnoea, chest pains, or haemoptysis; two patients had extremity swelling and tenderness alone; four patients had both respiratory distress and distal sites of infection. The hospital stay ranged from 27 to 90 days (average 44.7 days). Seven patients who had community acquired infections were previous healthy and had no predisposing factors for staphylococcal bacteraemia. Case 6 had underlying β thalassemia major presenting with suppurative otitis media of the left ear, fever, and chest pain.¹⁷ Patients 9 and 10 were premature babies at gestational ages 30 weeks and 27 weeks respectively. Both had received surfactant therapy. Patient 10 underwent a surgical ligation of patent ductus arteriosus; she

Abbreviations: CAMRSA, community acquired methicillin resistant *S aureus*; CT, computed tomography; MRSA, methicillin resistant *S aureus*; PE, pulmonary embolism

Table 1 Clinical features of 10 children with septic pulmonary embolism

Case	Age/sex	Presenting complaints	Foci of infection	Organisms	Susceptibility							Therapy	
					OX	PN	CL	SX	TE	VM	E	Pulmonary	Extrapulmonary
1	13 y/M	Fever, tachypnoea, haemoptysis	Right gluteal skin ulcer	SA	R	R	S	S	S	S	S	A	Abscess drainage
2	7 y/F	Right lower leg limping gait	Right distal tibia osteomyelitis	SA	R	R	R	S	S	S	R	A	Sequestrectomy, pus drainage
3	13 y/F	Chest pain, right knee swelling	Right knee pyomyositis	SA	S	R	S	S	S	S	R	A	Fasciotomy + abscess drainage
4	16 y/M	Haemoptysis, chest pain, right scalp parietal pain	Scalp cellulitis and abscess	SA	R	R	R	S	S	S	R	A	Abscess drainage
5	15 y/M	Tachypnoea, chest pain	Unknown	SA	R	R	R	S	S	S	R	A + thoracotomy	Nil
6	12 y/F	Fever, chest pain, left post-auricular pain	Suppurative otitis media	KP*	NA	NA	NA	NA	NA	NA	NA	A	Nil
7	12 y/F	Left elbow pain with dyspnoea	Left humerus osteomyelitis with pyomyositis	SA	R	R	R	S	S	S	R	A	Exploration, debridement
8	7 y/F	Right knee and hip pain	Pyomyositis of right quadriceps	SA	R	R	R	R	S	S	R	A	Debridement of pyomyositis
9	15 d/M	Cyanois with bradycardia	Bacterial conjunctivitis	SA	R	R	R	R	S	S	R	A + needle aspiration	Nil
10	12 d/F	Hypoxaemia	Umbilical vein catheterisation with infection	SA	R	R	R	R	S	S	R	A + chest tube drainage	Nil

SA, *Staphylococcus aureus*; KP, *Klebsiella pneumoniae*; OX, oxacillin; R, resistant; S, susceptible; NA, not applicable; PN, penicillin; CL, clindamycin; SX, trimethoprim/sulfamethoxazole; TE, teicoplanin; VM, vancomycin; E, erythromycin; A, antibiotic therapy.

*KP: susceptible to cefuroxime, ceftazidime, ceftazidime, gentamicin, amikacin, ciprofloxacin.

developed suppurative discharge at the site of umbilical vein catheterisation, together with multiple nodular skin lesions at right ankle and left knee. Only two patients underwent echocardiography. Neither had valvular anomalies or vegetation. All 10 patients survived.

Pulmonary outcome

Patient 5 required open thoracotomy for treatment of a left sided tension pneumothorax and empyema. He subsequently required repeated insertion of a chest tube for recurrent pneumothorax caused by ruptured pneumatocele. Patient 9 underwent bilateral percutaneous needle aspiration of lung abscesses. Pneumatocoele and chest wall retraction persisted at three months after discharge. Patient 10 had a tube drainage of a lung abscess.

Extrapulmonary sequelae

Soft tissue abscess formations were found in cases 1, 3, 4, and 8; each required local drainage, exploration, or debridement. Patients 2 and 7 had osteomyelitis at respectively the right distal tibia and left humerus, both of which needed open drainage. Patient 2 had chronic osteomyelitis and required oral antibiotics for three months. Endogenous endophthalmitis developed in patient 6 as reported previously.¹⁷

Radiographic findings

Table 2 summarises the radiographic features of septic PE of these 10 patients. Diffuse bilateral nodular lesions were seen on radiographs in 70% of patients (fig 1A). Nodular densities, pulmonary cavities, and bilateral parenchymal involvement were seen in 80% of the patients on chest CT (fig 1B), five of whom had the "feeding artery" sign. Cases 9 and 10 had large solitary lung abscesses with an air-fluid level on frontal chest radiographs (fig 2A,B). Pneumatocoeles developed in cases 5 and 9 after the acute embolic stage of the disease (fig 2C). Empyema or pleural effusions were noted in six patients. One patient developed a pneumothorax.

Bacteriology and antimicrobial susceptibility

Staphylococcus aureus was the aetiological pathogen in nine patients, eight of which were methicillin resistant *Staphylococcus aureus* (MRSA) (table 1). Seven had community acquired MRSA without predisposing factors. One MRSA isolate was hospital acquired with prior antibiotic therapy and associated with umbilical vein catheterisation. Case 6 had *Klebsiella pneumoniae* septicemia with underlying β thalassemia major following suppurative infection of the left ear. All nine patients with staphylococcal infections received vancomycin therapy before the drug susceptibility results were known;

Table 2 Radiographic features of septic pulmonary embolism in the 10 patients

	Plain radiograph (n=10)		Chest CT scan (n=7)	
	No.	%	No.	%
Nodular lesions	7	70	7	100
Bilateral	7	70	6	85.7
Diffuse (unilateral lesion >2 sites)	6	60	5	71.4
Cavity formation	5	50	7	100
Pleural effusion/empyema	5	50	6	85.7
Pneumothorax	1	10	1	14.2
Feeding artery sign	NA		5	71.4
Hilar/mediastinal lymphadenopathy	0	0	0	0

NA, not applicable.

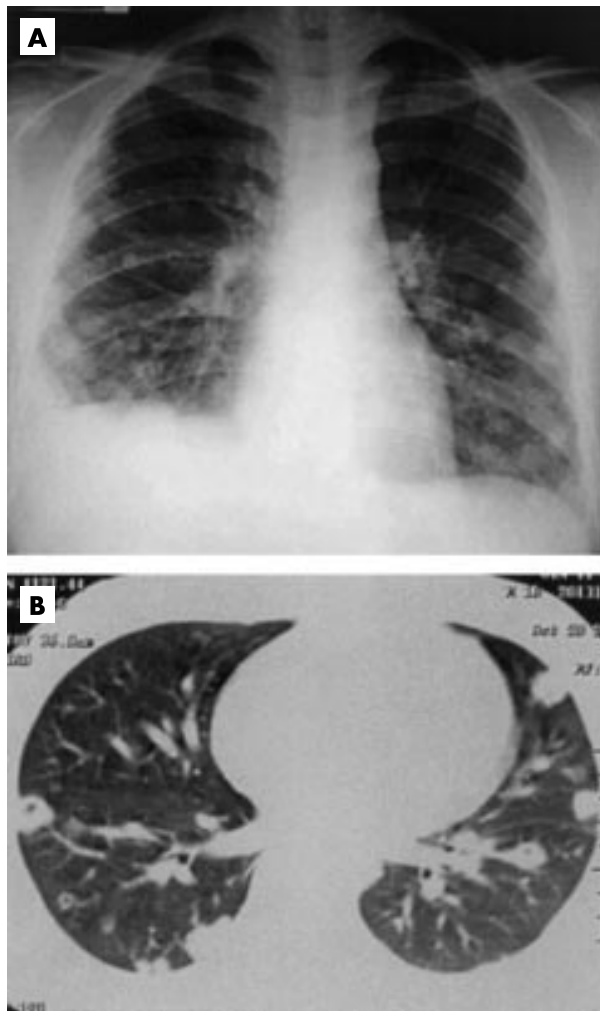


Figure 1 (A) Posteroanterior chest radiograph shows ill defined areas of consolidation in peripheral portions of both lower lobes (case 1). (B) CT section below carina. Scattered nodules in both solid and cavitations, most of which are compatible with haematogenous seeding (case 1).

patient 3 was given oxacillin therapy after the confirmation of susceptibility.

DISCUSSION

Clinically, all patients in this series were septic and toxic with evidence of metastatic infections. Two patients (cases 2 and 8) did not have respiratory embarrassment despite significant pulmonary abnormalities. Causes of septic PE in children described in the literature include right sided bacterial endocarditis, septic thrombophlebitis, osteomyelitis, soft tissue infections, or urinary tract infections.^{1-3 9 10 12 14 15} The commonest causes of septic PE in this study were soft tissue and bone infections. If the source is not clinically evident, a bone scan or white cell label scan may identify a focus.

The pulmonary manifestations and radiographic changes of septic emboli are indicative of underlying infections. Early awareness and recognition of septic PE guide the right choice of antibiotics. Typical radiographic features of septic PE typically include patchy air space lesions simulating non-specific bronchopneumonia; multiple ill defined round or wedge shaped densities of varying sizes from 0.5 to 3.5 cm located peripherally; lesions abutting the pleura and located at the end of vessels (feeding vessel sign) seen on chest CT scans.^{3 5-7} Other pulmonary features suggesting septic PE include bilateral, occasional unilateral, rapid progression of

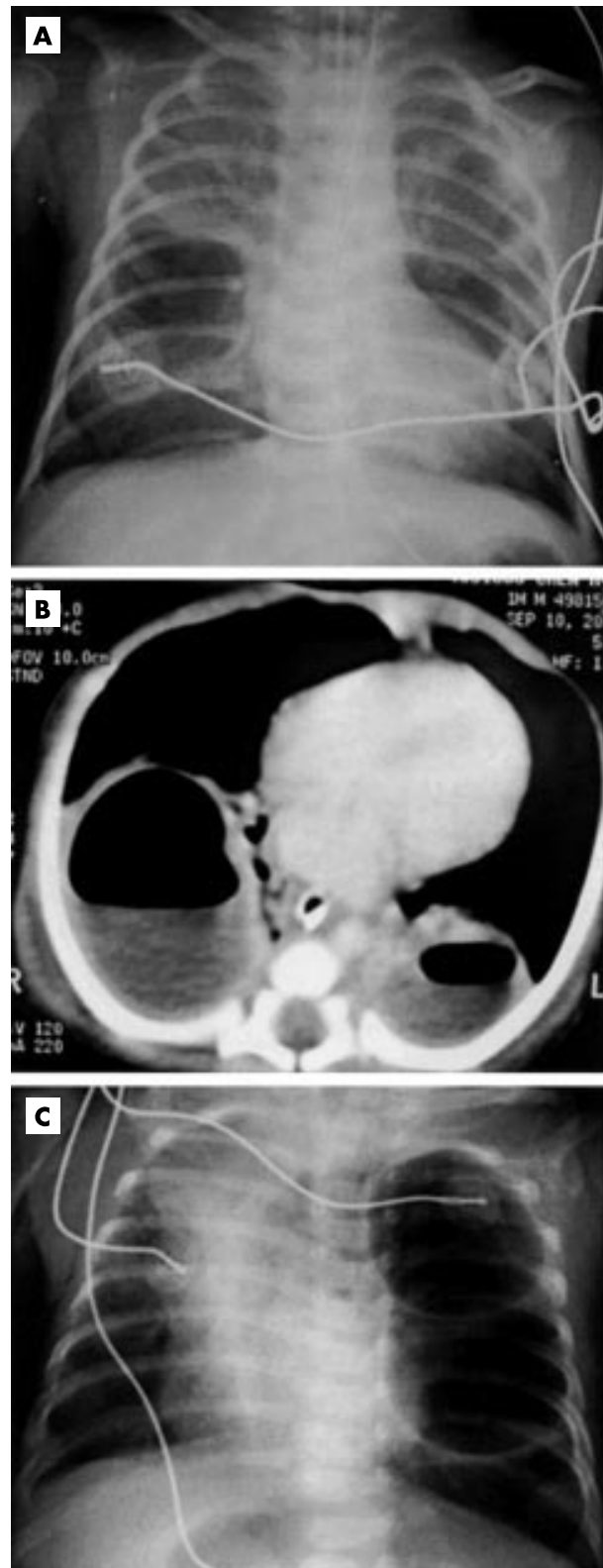


Figure 2 (A) Frontal chest radiograph shows large sized cavitations on both lung fields (case 10). (B) Chest CT axial view shows bilateral lung abscesses with air-fluid level (case 10). (C) Large pneumatocele in the left lung noted two months after discharge (case 10).

cavities or abscess formations.^{3 5-7} Empyema, bronchopleural fistula, and pneumothorax were not common in this study.^{3 6} Hilar or mediastinal lymph node enlargement have been described but was not seen in our patients.

Primary staphylococcal pneumonia is usually unilateral. We presume the lung abscesses seen in patients 9 and 10 were secondary to septic embolisation, because they had previous umbilical catheterisation and preceding staphylococcal bacteraemia.

Children with staphylococcal bacteraemia are particularly prone to osteitis and myositis.¹⁴ In a study of 113 adults patients with community acquired *S aureus* bacteraemia there was a high mortality of 35%.¹⁸ In methicillin sensitive *S aureus* infections, β lactam antibiotics are preferred, since glycopeptides (vancomycin and teicoplanin) are less bactericidal than β lactams.^{19–22} Previously, MRSA has been most commonly seen in hospitalised patients with prolonged hospitalisation, invasive or surgical procedures, indwelling catheters, endotracheal intubation, or prolonged or recurrent exposure to antibiotics.^{23–26} Glycopeptides are the drugs of choice for treating severe infections caused by methicillin and other β lactam resistant staphylococci.¹⁹

Community acquired MRSA (CAMRSA) infections have been uncommon in the past. However, MRSA infections with no risk factors have become an important problem worldwide.^{20–22} In a recent report of four paediatric deaths caused by CAMRSA infections, the children had been initially treated with a cephalosporin antibiotic. The rationale of changing the empiric selection of antibiotics in order to assure appropriate coverage in severely ill children should therefore be emphasised. For critically ill patients with suspected CAMRSA infections, especially soft tissue infections such as cellulitis or abscess, vancomycin should be the initial empiric antibiotic because β lactams in general are ineffective for treating MRSA infections in such circumstances. Failure to respond promptly to adequate antibiotic treatment and continuing pulmonary seedings by septic PE signify the necessity for early surgical drainage of the infective lesion.

Conclusions

Pediatricians should be familiar with the radiographic features of PE to avoid delay in prompt diagnosis and therapeutic decisions. Although MRSA has not been a frequent pathogen in community acquired infections, paediatricians should be aware of this possibility. Its presence is no longer confined to children with established risk factors. CAMRSA infections present in children with skin, soft tissue, and bone and joint infections. Bacteraemia caused by *S aureus* infections generally needs prolonged antibiotic therapy and has been associated with high morbidity and mortality. The emergence of CAMRSA as a cause of infections requires a change in the initial selection of antibiotics, such as glycopeptides (vancomycin or teicoplanin) to ensure appropriate coverage in critically ill children.

Authors' affiliations

K S Wong, T Y Lin, Y C Huang, S H Hsia, P H Yang, S M Chu,
Department of Pediatrics, Chang Gung Children's Hospital, Taoyuan,
Taiwan

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