ment in the special care baby units attached to district general hospitals, and that such cases seldom require transfer to a regional intensive care neonatal unit.

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Causes of 'Delayed' Respiratory Distress in Infancy

There are many causes of respiratory distress starting more than one week after birth in infants who have had no, or only transient and minor, respiratory problems immediately after birth. They may be divided into two broad groups; those with primary pulmonary pathology and those with extrapulmonary pathology with secondary effects on lung expansion. Table 1 comprises a list of causes subdivided in this way which is by no means exhaustive.

Table 1

Causes of 'delayed' respiratory distress in infants

Primary pulmonary causes:
Wilson-Mikity syndrome
Chylothorax and congenital pulmonary lymphangiectasia
Congenital lobar emphysema
Cystic fibrosis
Hystiocytosis X
Acute infections
Extrapulmonary causes:
Congenital heart disease
Foregut duplication
Tracheo-œsophageal fistula
Diaphragmatic hernia
Asphyxiating thoracic dysplasia

The Wilson-Mikity Syndrome

The Wilson-Mikity syndrome is a rare condition of delayed respiratory distress affecting only a tiny specific group of newborn babies. The first report of 5 cases (Wilson & Mikity 1960) was followed by 34 cases (Hodgman *et al.* 1969) from which the essential features were derived. The respiratory distress occurs in premature rather than dysmature infants, usually those weighing 1– 1.5 kg at birth, born after 24–36 weeks gestation. The estimated incidence in this group is 1 in 90.

There is an insidious onset of increasing breathlessness, cyanosis, cough and wheeze, starting usually after the first week of birth. Symptoms then increase in severity for four to six weeks during which there is a 25% mortality from pulmonary insufficiency or right heart failure. The survivors gradually recover over three to twenty-four months, during which time they are unusually susceptible to acute respiratory infections, but recovery is eventually complete. The pathology is immature lung with variable hyperinflation and collapse and the pathogenesis may be abnormal ventilation-perfusion ratios related to pulmonary immaturity.

Radiological appearances may be divided into three stages (Grossman *et al.* 1965) corresponding to the period of severe illness, the period of improvement and the time of recovery. The earliest changes, appearing between the third and thirty-fifth day after birth, are diffuse linear streakings with small radiolucent ring shadows which develop a bubbly appearance with larger radiolucent rings and wide linear bands which last from thirty to one hundred days (Fig 1). The stage of recovery is characterized in X-rays by the disappearance of the ring shadows with residual basal hyperinflation and upper lobe linear bands (Fig 2) lasting one to six months, during which time the child is susceptible to recurrent respiratory infections. The X-ray appearances become normal between three and twenty-four months of age and clinical recovery is by then also complete.

The differential diagnosis of Wilson-Mikity syndrome is clinical rather than radiological, as the radiological appearances during the period of severe illness are identical to those which have been reported in bronchopulmonary dysplasia (Northway & Rosan 1968). However, bronchopulmonary dysplasia, together with idiopathic respiratory distress syndrome and meconium aspiration syndrome (Tudor *et al.* 1976), is characterized by severe respiratory distress developing within twenty-four hours of birth without the latent, symptom-free period found in the Wilson-Mikity syndrome. The infant liable to complications of artificial ventilation will also have presented an acute episode requiring ventilation, rather than the insidious onset of dyspnœa and wheeze, although

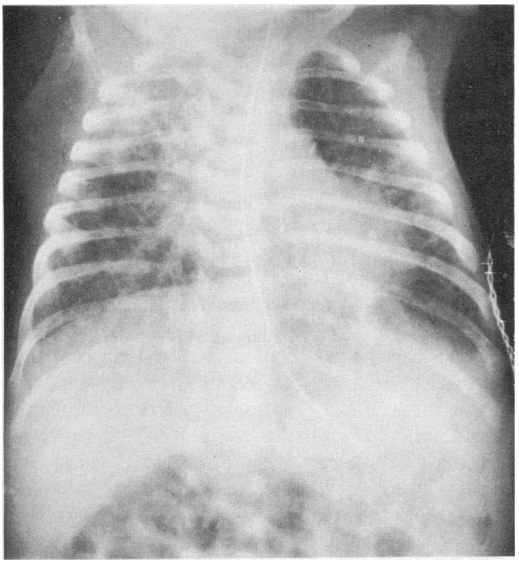

Fig 1 **Case 1** *Severe phase of Wilson-Mikity syndrome. Overinflated lung fields with coarse bubbly pattern present throughout*

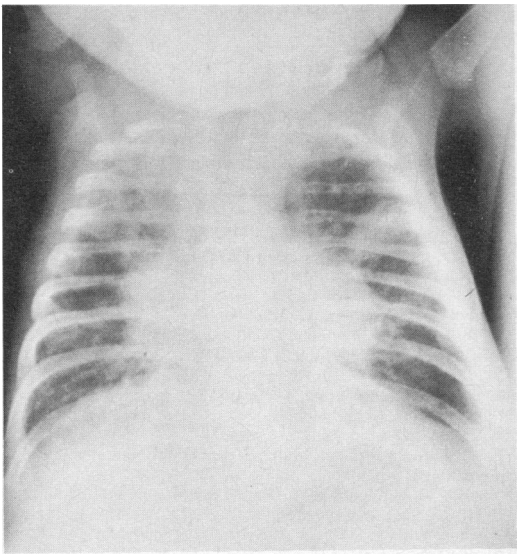

Fig 2 **Case 1** *Phase of recovery with broad bands of collapse evident in right upper and mid-zones and left mid-zone, with lower zone overinflation*

Wilson-Mikity syndrome has been observed in survivors of hyaline membrane disease who had been ventilated, receiving oxygen under positive pressure (Rudhe & Broberger 1967).

Case 1 (Dr John Maclaurin and Dr Ellis Barnett): Admitted to the Royal Hospital for Sick Children, Glasgow, aged 3½ months, with an acute upper respiratory infection but a normal chest X-ray. Previous history was typical of Wilson-Mikity syndrome. She was born after 31 weeks' gestation weighing 1.6 kg at Glasgow Royal Maternity Hospital. A mild aspiration syndrome was demonstrated at 24 hours of age but the next 3 weeks were uneventful. At that time she became wheezy, blue, distressed, was not improved by oxygen therapy and X-ray showed overinflated lungs with small areas of collapse. A week later (Fig 1) a coarse, bubbly pattern was apparent and soon after this slow improvement took place. At 6 weeks (Fig 2) typical upper zone linear bands of collapse were apparent, the baby was less distressed and started to thrive. Recovery was radiologically complete by 3½ months.

Idiopathic Chylothorax and Congenital Cystic Lymphangiectasia

Idiopathic chylothorax is the most common neonatal pleural effusion (Bornhurst & Carsky 1964) and the majority of cases appear to be the result of immature lymphatic development rather than the result of birth trauma. While the effusions are usually on the right they are sometimes bilateral and may be large enough to cause respiratory embarrassment. This is relieved by aspiration which may have to be repeated before an apparently spontaneous cure. Repeated reaccumulation has led to surgical exploration of the thoracic duct, but this does not necessarily reveal any leak or interruption.

In 1967 Frostin *et al.* collected 32 cases of congenital cystic lymphangiectasia. Most of these showed symptoms within twenty-four hours of birth and over 50% were associated with congenital heart disease, usually left heart hypoplasia. However, some cases presented later and a few were not fatal. Associated chylothorax does not seem to have been reported.

Case 2 (Fig 3): Admitted at 6-weeks-old, with dyspnœa developing gradually in the preceding 2 weeks. The right-sided effusion was aspirated. The effusion re-collected rapidly for 6 more weeks, requiring repeated aspiration. Feeding with medium chain triglycerides to replace fat was tried without apparent reduction in volume of effusion, but then quite suddenly spontaneous cure occurred. However, on all films both lung fields (Fig 4) always appeared abnormal with a reticular background pattern. A diagnosis of congenital cystic lymphangiectasia was postulated but is as yet unconfirmed. It persists at 6 months, but as the child is thriving a diagnostic lung biopsy has been postponed.

Congenital Lobar Emphysema

Congenital lobar emphysema usually presents in the first few months of life (Leape & Longino 1964). Although the progressive air trapping on expiration appears to be associated with collapse of the tracheal or bronchial walls, pathological proof of tracheomalacia, such as deficient cartilaginous rings, is rarely found. The condition must be recognized promptly as it can be rapidly fatal from circulatory embarrassment associated with the mediastinal shift and obstructed pulmonary

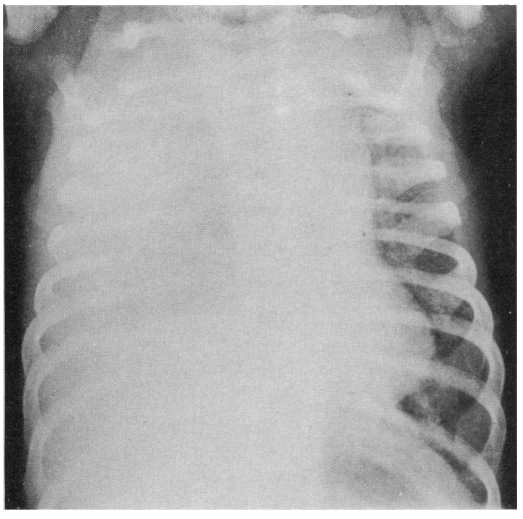

Fig 3 **Case 2** *Chylothorax with mediastinal displacement to the left associated with a right pleural effusion and compression of underlying right lung*

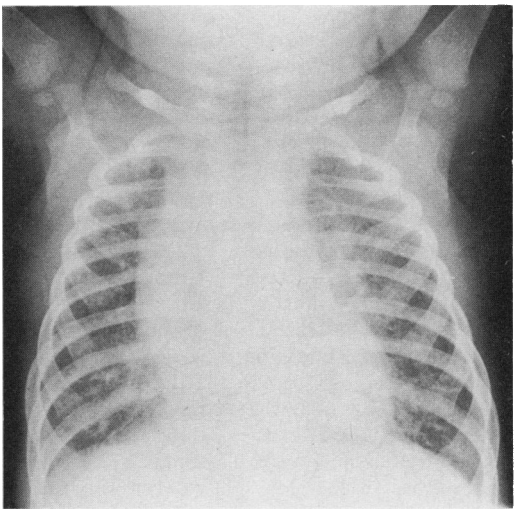

Fig 4 **Case 2** *Unconfirmed congenital cystic lymphangiectasia with an abnormal reticular pattern throughout both lung fields, after recovery from right chylothorax*

perfusion (Floyd *et al.* 1963). While one lobe is usually affected, the condition may affect more than one. Thus, attempts have been made recently at conservative management by intubation and controlled ventilation to overcome what may be a temporary impairment of lung function, rather than emergency lobectomy to remove what is usually an apparently anatomically normal lobe (Campbell *et al.* 1977).

Cystic Fibrosis

An infant with a persistent, dry, hacking cough and failure to thrive may have cystic fibrosis, especially in the West of Scotland where this recessive gene is common. The overall incidence is said to be 1:600 of the population. Preceding meconium ileus makes the diagnosis simple and respiratory symptoms may develop in the first few weeks of life (Kirkpatrick 1967). Respiratory involvement often progresses in spite of supportive therapy and leads to an early death, although in certain parts of Great Britain there are reports of a rather less gloomy prognosis (Robinson & Norman 1975) possibly related to better social conditions. The earliest radiological sign of pulmonary involvement is generalized overinflation of the lungs with or without areas of collapse; appearances are indistinguishable radiologically from acute bronchiolitis. A prolonged illness may suggest the diagnosis in the absence of a relevant family history.

Histiocytosis

Histiocytosis X, in its usually fatal infantile form of Letterer-Siwe's disease, presents within the first year of life and is the most common cause of spontaneous pneumomediastinum in infants between one week and one year (Baker 1963). In the absence of the typical skin rash which usually leads to the correct diagnosis, an infant exhibiting respiratory distress with a 'ground glass' pattern of generalized loss of radiolucency which, however, reveals tiny areas of overinflation on magnification of a top quality radiograph, should, particularly if there is an associated pneumomediastinum or pneumothorax, have a full skeletal survey to seek out characteristic bone lesions. There may be 'punched out' osteolytic areas in the skull and pelvis or expanding osteolytic lesions in the shafts of long bones or ribs.

Case 3: Presented at 6 months with clinical evidence of superior mediastinal obstruction showing a ground glass pulmonary with tiny areas of focal overinflation and a wide superior mediastinal shadow. Skull X-ray revealed a small posterior parietal osteolytic lesion and a few days later acute dyspnœa heralded a left pneumothorax and pneumomediastinum. The boy died a few months later.

Infection

Infection may cause respiratory distress starting any time after birth and may be viral or bacterial (Rice & Loda 1966). With the falling acceptance of the proffered immunization programmes, one agent which will almost inevitably become more prevalent is whooping cough.

Congenital Heart Disease

Congenital heart disease may be responsible for respiratory embarrassment starting at any time. A relatively common time for it to become manifest is about the tenth day of life associated with the closure of the ductus arteriosus, when a barely

adequate pulmonary blood flow may be converted into a definitely inadequate one in lesions involving pulmonary outflow obstructions (Lucas *et al.* 1963), or when cardiac failure may be precipitated in preductal coarctation of the aorta (Talner & Berman 1975).

Foregut Duplications

Foregut duplications are not invariably associated with respiratory symptoms, but a high bronchogenic cyst at the thoracic inlet may cause stridor and a variable swelling in the suprasternal notch if moving with the trachea on respiration (Caffey 1973). Sonar examination now provides a useful adjunct to radiography in the diagnosis of such lesions and also of posterior mediastinal neurenteric cysts, which can be differentiated from neurofibromas and neuroblastomas by the transonic nature of their content (Sweet, in preparation).

Tracheo-œsophageal Fistula

Tracheo-œsophageal fistulæ without œsophageal atresia may be impossible to confirm without ciné-radiography, which should be performed by distending the œsophagus from distal limit proximally with thin barium suspension, given with the child in the prone position (Sauvegrain 1969). A fistula must be considered in the differential diagnosis of aspiration pneumonia, particularly if there is a history of coughing or colour change related to feeding (Sieber & Girdany 1956).

Diaphragmatic Hernia

While a diaphragmatic hernia may produce dyspnœa within hours of birth, sometimes attributable to pulmonary hypoplasia more than to the hernia itself (Chatrath *et al.* 1971), smaller hernias in infants with normal lung development may cause distress later.

Case 4: Admitted at 6-weeks old from a fever hospital, where right-sided staphylococcal pneumonia had been suspected originally. On alimentary tract contrast examination shown to have a large right-sided diaphragmatic hernia containing liver and small bowel.

Asphyxiating Thoracic Dysplasia

Since Jeune's original descriptions (Jeune *et al.* 1954, Jeune *et al.* 1955) of 2 fatal cases of asphyxiating thoracic dysplasia, a more benign form has been recognized (Neimann *et al.* 1963) which is not necessarily fatal.

Case 5: Acutely distressed infant, admitted at 6 weeks with a prolonged severe attack of acute bronchiolitis. Noted to have short ribs. Subsequent X-rays of lumbar spine and pelvis showed the characteristic flat trident acetabular roofs, early ossification of femoral heads, rather small sciatic notches but normal lumbar interpedicular distances, confirming asphyxiating thoracic dysplasia.

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Human Fetal Breathing in Utero
Dr Duncan Gough
(*Oxford*)

Airway Reflexes and Regulation of Breathing at Birth
Dr Paul Johnson
(*Nuffield Institute for Medical Research, Headington, Oxford*)

Clinical Management of Hyaline Membrane Disease and Complications of Treatment
Dr Simon Godfrey
(*Hammersmith Hospital, London W12 OHS*)

Respiratory Distress in the Early Neonatal Period
Professor R E Steiner
(*Hammersmith Hospital, London W12 OHS*)