Case 1: Extracorporeal membrane oxygenation (ECMO) cardiopulmonary support in infancy. Bartlett RH and colleagues. Trans Am Soc Artif Intern Organs. 1976;22:80-93.

We have used prolonged extracorporeal membrane oxygenation (ECMO) in the treatment of 13 moribund infants (including 9 neonates), with 4 survivors (3 neonates). Successfully treated cases include post-operative cardiac failure, infant respiratory distress syndrome, massive meconium aspiration, and persistent fetal circulation. All cases have been managed with veno-arterial bypass at flow rates of 80-100 cc/Kg/min. Carotid cannulation for arterial access and careful control of heparin anticoagulation based on whole blood activated clotting time are among the techniques which have contributed to this success. Progressive pulmonary or cardiac failure has been the major problem in older infants, intracranial bleeding is the major problem in neonates. Both of these problems could be minimized by instituting ECMO earlier in the clinical course, but this awaits development of reliable early predictors of mortality.

Case 2: Extracorporeal circulation (ECMO) in neonatal respiratory failure. Bartlett RH and colleagues. J Thorac Cardiovasc Surg. 1977 Dec;74(6):826-33.

Sixteen moribund newborn infants with respiratory failure were treated with extracorporeal membrane oxygenation (ECMO) for 1 to 8 days. Cannulation via the right jugular vein and carotid artery was used to establish venoarterial-cardiopulmonary bypass. High flow (80 percent of cardiac output) allowed decreasing FIO2 and airway pressure. Diagnoses and results were as follows: respiratory distress syndrome, four patients (two improved, one survived); meconium aspiration syndrome, eight patients (four improved, three survived); persistent fetal circulation (some with diaphragmatic hernia), four patients (three improved, two survived). Intracranial bleeding occurred in 43 percent, accounting for most of the deaths. In a parallel series of 21 infants treated with conventional ventilator therapy, the mortality rate was 90 percent and intracranial bleeding occurred in 57 percent. ECMO provided life support and gains time in newborn respiratory failure. In high mortality risk infants, the rate of survival is higher and intracranial bleeding lower with ECMO than with optimal ventilator management.

Case 3: Extracorporeal Circulation in Neonatal Respiratory Failure: A Prospective Randomized Controlled Study. Bartlett RH and colleagues. Pediatrics. 1985 Oct;76(4):479-87.

A prospective controlled randomized study of the use of extracorporeal membrane oxygenation to treat newborns with respiratory failure was carried out using the "randomized play-the-winner" statistical method. In this method the chance of randomly assigning an infant to one treatment or the other is influenced by the outcome of treatment of each patient in the study. If one treatment is more successful, more patients are randomly assigned to that treatment. A group of 12 infants with birth weight greater than 2 kg met objective criteria for high mortality risk. One patient was randomly assigned to conventional treatment (that patient died); 11 patients were randomly chosen for extracorporeal membrane oxygenation (all survived). Intracerebral hemorrhage occurred in one of 11 surviving children. Extracorporeal membrane oxygenation allows lung rest and improves survival compared to conventional ventilator therapy in newborn infants with severe respiratory failure.

Case 4: National experience with extracorporeal membrane oxygenation for newborn respiratory failure. Data from 715 cases. Toomasian JM and colleagues. ASAIO Trans. 1988 Apr-Jun;34(2):140-7.

In a national registry, data were collected on 715 newborn patients with severe respiratory failure supported by extracorporeal membrane oxygenation (ECMO) in 18 neonatal centers. This represents almost all infants treated with ECMO between 1980 and 1987. Eighty-one percent of the patients survived. This result is statistically significantly better than any other treatment which produces less than 78.4% survival. The most common diagnoses were meconium aspiration (310 patients, 91% survived), respiratory distress syndrome (96 patients, 78% survived), diaphragmatic hernia (121 patients, 65% survived), and sepsis (64 patients, 72% survived). Average pre-ECMO characteristics were: age 59 hours; PaO2 42 torr, PaCO2 41 torr, pH 7.40; ventilator settings FiO2 1.0, pressure 45/4 cmH2O, rate 93. Technical complications occurred in 23.1%, and physiologic complications occurred in 65.6%. Results improved with experience. Survival rate for the first ten patients from each center was 73.5% compared to 83.7% for all subsequent patients. Survival rate did not, however, significantly differ after an institutional experience of 20 patients. These observations were made on a large cohort that could not be accumulated at an individual center. These results indicate that ECMO and lung rest is appropriate and successful treatment for newborn respiratory failure unresponsive to other means of management, and that almost all respiratory failure is reversible in near-term neonates.

Case 5: Follow-up of infants treated with extracorporeal membrane oxygenation for newborn respiratory failure. Schumacher RE and colleagues. Pediatrics. 1991 Apr;87(4):451-7.

Follow-up studies were conducted to assess the medical and developmental outcome of 92 infants treated with extracorporeal membrane oxygenation at the University of Michigan. Of 118 near-term (greater than 34 weeks' gestation) infants who received extracorporeal membrane oxygenation, 103 (87%) were surviving and available for follow-up at between 1 and 7 years of age. Ninety-two of these children were seen on at least one occasion. Each visit included a history and physical examination, an evaluation by a physical therapist, and developmental testing by a pediatric psychologist. Medical outcome during year 1 found 31% of the children rehospitalized, primarily with respiratory illness. Outpatient-treated lower respiratory tract illness was seen in an additional 31% of the children. New or nonstatic neurologic problems were noted in 6% of the children. Abnormal growth during year 1 occurred in 26% of the children. At last clinic visit 16% of the children exhibited moderate-to-severe neurologic abnormalities, and 8% had moderate-to-severe cognitive delay. Sensorineural hearing loss occurred in 4% of children. Nine percent of the children were receiving speech and language therapy; screening tests showed that an additional 6% had speech and language delay. Overall, at last visit 16 (20%) of the children exhibited some type of handicap. A review of the literature on follow-up studies of non-extracorporeal membrane oxygenation-treated infants with persistent pulmonary artery hypertension produced an impairment rate of 18.5%. Outcome post-extracorporeal membrane oxygenation appears similar to that seen in less ill cohorts of infants treated with more "conventional" therapy. Long-term follow-up of all such infants remains essential.

Case 6: UK collaborative randomised trial of neonatal extracorporeal membrane oxygenation. UK Collaborative ECMO Trail Group. Lancet 1996; 348(9020):75–82.

BACKGROUND: Extracorporeal membrane oxygenation (ECMO) is a complex and expensive technology that can be used to provide temporary support during respiratory failure. Its value for mature newborn infants is controversial because of varying interpretation of the available evidence. We undertook a collaborative trial throughout the UK to assess whether a policy of referral for ECMO has a beneficial effect on survival to 1 year without severe disability in comparison with conventional management.

METHODS: Between 1993 and 1995, 185 mature (gestational age at birth > or = 35 weeks, birthweight > or = 2 kg) newborn infants with severe respiratory failure (oxygenation index > or = 40) were enrolled from 55 hospitals in a randomised comparison of either referral to one of five specialist centres for consideration of ECMO or continued intensive conventional management at the original hospital. The most common diagnoses were persistent pulmonary hypertension due to meconium aspiration, congenital diaphragmatic hernia, isolated persistent fetal circulation, sepsis, and idiopathic respiratory distress syndrome. Of the infants allocated ECMO, 84% received this support. Recruitment to the trial was stopped early (November, 1995) by the trial steering committee on the advice of the independent data-monitoring committee, because the data accumulated showed a clear advantage with ECMO. 124 children were enrolled before December, 1994; those who survived to 1 year of age have undergone neurological assessment at that age (by one of three developmental paediatricians unaware of treatment allocation).

FINDINGS: Overall, 81 (44%) infants died before leaving hospital, and two are known to have died later. Death rates differed between the two trial groups; 30 of 93 infants allocated ECMO died compared with 54 of 92 allocated conventional care. The relative risk was 0.55 (95% Cl 0.39-0.77; p = 0.0005), which is equivalent to one extra survivor for every three to four infants allocated ECMO. The difference in survival applied irrespective of the primary diagnosis, disease severity, and type of referral centre. The benefit of ECMO was also found for the primary outcome measure of death or disability at 1 year (among 124 children enrolled before December, 1994). One child in each group has severe disability (overall Griffiths' developmental quotient < 50, or untestable), and 16 (ten ECMO, six conventional management) have impairments with a lesser degree of disability.

INTERPRETATION: These preliminary results demonstrate the clinical effectiveness of a well-staffed and organised neonatal ECMO service. ECMO support should be actively considered for neonates with severe but potentially reversible respiratory failure.

Full list of references for the talk: