INTRODUCTION AND SUMMARY

The adult respiratory distress syndrome (ARDS) became a clinical entity in medicine during the late 1950's and early 1960's with the development and widespread use of intensive care facilities for seriously ill medical and surgical patients. The early successes reached in treating these seriously ill patients was achieved by bringing together expertise in pulmonary and cardiac pathophysiology coupled with the availability of respiratory ventilators. Many of these patients went on to develop ARDS, whereas ten years earlier they would have succumbed to their initial illness. This event in the early 1960's resulted in over two decades of intensive investigation and application of many new interventions to understand, diagnose, prevent and treat ARDS resulting from a variety of causes.

One such intervention proposed was extracorporeal membrane oxygenation (ECMO). The principle was simple and not original. If a patient was dying due to a pathological process in his/her lungs, that prevented sufficient oxygen and carbon dioxide to traverse the alveolar membrane, then the employment of an artificial and extracorporeal gas exchange device that would sustain the patient until such time as his/her lungs recovered was proposed. For this premise to succeed two things had to be true and/or possible. One, the lungs, in fact, had to have the capacity to recover over time; and two, ECMO had to be done safely and efficiently without significant, secondary complications of its own. Now, two decades later, we know that ECMO can, under most specified circumstances, be done safely. However, the inability of the biological lung to recover with time has been a major limiting factor in the widespread successful use of this therapy. ECMO in the treatment of ARDS has some specifically defined applications where it has proven to be a significant adjunct to conventional therapy. However, considering the magnitude of the problem, and the number of deaths per year attributed to ARDS, ECMO now, and in this coming decade, will not have a significant impact on this syndrome. However, in the neonate with respiratory distress syndrome, ECMO has been successful and will continue to play a significant role in this syndrome in the coming years.

THE EQUIPMENT

The first successful prototype of a membrane oxygenator was developed by Clowes.\[1\]
The Bramson membrane oxygenator was the first successful device that was commercially available and used in any significant numbers. Until recently, the development of membrane oxygenators has been hindered by their inability to compete with the simplicity and economics of bubble oxygenators. Most investigators and clinicians readily acknowledged that on a theoretical basis membrane oxygenators were superior to conventional oxygenators. However, for the length of perfusion necessary in routine open heart surgery disposable, simple and economical bubble oxygenators were performing well. Furthermore, no investigator in controlled randomized studies could demonstrate the superiority of the membrane oxygenator for use in routine open heart surgery. Conversely, no one could demonstrate that bubble oxygenators could be used successfully for long-term respiratory support, as membrane oxygenators had been successfully used in animal experiments. Now this is changing. There are a number of commercially available membrane oxygenators that are used in routine open heart surgery and are possible devices for use in ECMO. Each has its individual advantages and disadvantages but all have been demonstrated to be effective and safe in routine open heart surgery, and are being developed further for use in chronic membrane oxygenation. The two most important features that a membrane oxygenator should have for use in ECMO are continued efficiency and safety during long-term use and relative antithrombogenic characteristics. At this point all patients undergoing ECMO must still receive some Heparin to prevent thrombogenesis in the extracorporeal circulation. However, to the extent that a membrane oxygenator, through its design and the surface characteristics of its membrane, is antithrombogenic is a distinct advantage in the overall management of the patient.

THE ADULT RESPIRATORY DISTRESS SYNDROME

As noted above, ARDS became a clinically significant entity in the early 1960's with the development of intensive care units, which arose with the complications associated with the immediate post-operative care of open heart surgical patients. The etiology, pathogenesis and therapy of this syndrome were not understood in the early 1960's. The introduction of PEEP by Hill et al in 1965 was the first significant mechanical intervention other than ventilators that improved serious respiratory hypoxia in post-operative open heart surgical patients. Later in 1967, pulmonary clinicians soon successfully applied PEEP therapy to patients with ARDS arising from other causes. Since that time, an enormous amount of scientific literature has been published on the etiology, prevention and treatment of this syndrome so that now it is a much less commonly seen complication in medical and surgical ICU's. Therefore, potential candidates for ECMO are also less frequently seen. However, when identified they are more seriously ill because conventional means have failed to bring them under control.

The first attempts to treat ARDS with ECMO took place in the late 1960's. Success came in 1971 when Hill treated a patient dying with ARDS associated with trauma. In the following three years sporadic success was seen but there was still a lingering doubt whether ECMO per se was superior to conventional therapy. What was needed was a controlled, randomized study of conventional therapy and ECMO. This was organized in 1973 and completed in 1977. Nine different centers and approximately 100 patients entered into the trial. The results indicated that there was no statistical difference between patients treated with conventional therapy or ECMO. However, at the end of the study one