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Presidential Address

Discovery in surgery: Reflections on a golden age

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Next year we will celebrate the five hundredth anniversary of Columbus' discovery of the New World. As we meet now in our nation's capital, in the District of Columbia, we might consider the role that discovery has played in our profession. The analogy of surgery to the voyages of Columbus and Magellan is not exact, because our work involves manipulation as well as observation and exploration, but we share with the great navigators the quality of decisiveness often in the face of inadequate information. We sail on an ocean of mysterious biologic processes, in ships made fragile and leaky by our ignorance. But in the second half of this century we have come so far, so fast, that I believe this time deserves to be called a Golden Age.

If you doubt the significance of changes in our work, I would ask you to review the program of this Association 40 years ago. Most of the papers then described valiant efforts to stem the progress of tuberculosis and the largely futile procedures to alter the course of cancer. Compare that with this year's program: transplantation of hearts and lungs, revascularization of ischemic myocardium, preservation of organs, mechanical systems for circulatory support, and the application of the new molecular biology to such problems as cancer and transplantation. We have seen not only enormous enlargement in the scope of our interests, but also a major change in the effectiveness in our efforts as measured in the lives of our patients.

This golden age has a unique feature: It is still going on. Most golden ages were defined in retrospect. The ages of Pericles in Athens and Elizabethan England were recognized after the closing parentheses defined their end. We are lucky. We are part of a process that continues. The people in this room, and our colleagues, especially the new members and the not-yet members of this Association, will define how long this golden age will last and which directions it will take.

Before I speculate on these new directions, let me remind you of several of the milestones in our field over the past several decades. I have identified four events that I believe we would all accept as seminal contributions: the development of cardiopulmonary bypass, vascular prostheses, prosthetic intracardiac valves, and cardiac transplantation.

The concept of artificial oxygenation and pumping of blood goes back to the 1930s, when Carrel and Lindbergh showed that organs could be sustained on pump-oxygenators. But it remained for John Gibbon (Fig. 1), stimulated by the ineffective treatment of pulmonary embolus, to develop a system for total cardiopulmonary bypass. He demonstrated the effectiveness of this approach in a patient with an atrial septal defect. Gibbon's interest was

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Fig. 1. Dr. Gibbon.

focused on the physiology of cardiopulmonary bypass, but it remained for others, many in this room today, to apply this approach to correction of cardiovascular problems.

While Gibbon was working in Philadelphia, a young surgical resident in New York, Arthur B. Voorhees, Jr. (Fig. 2), discovered the secret that made vascular grafts possible. He was assigned the task of producing experimental mitral insufficiency. He passed a vinyon suture through the wall of the left ventricle and tried to pull the papillary muscle to the left ventricular wall. When he examined the heart 6 weeks later he found that he had failed to produce mitral insufficiency, but he saw that the vinyon suture, traversing the left ventricular cavity, was covered by material indistinguishable from endothelium. He reasoned that a flexible graft of plastic material might be used to bridge arterial defects, and he succeeded when all previous attempts, using rigid tubes, had failed.

Another young surgeon, Albert Starr (Fig. 3), who was trained in the same program as Voorhees at Columbia-Presbyterian, began his practice of cardiovascular surgery in Portland, Oregon. He was approached by an engineer, Lowell Edwards, who suggested a collaborative effort on an artificial heart. Dr. Starr suggested, rather, focusing their efforts on the development of an artificial intracardiac valve. After extensive animal studies, Dr. Starr implanted prosthetic valves in the mitral, aortic, and tricuspid positions and inaugurated the approach of valve replacement that today is used worldwide.

The field of cardiac transplantation was opened by two young surgeons at Stanford, Norman Shumway (Fig. 4) and Richard Lower, who found themselves with time on their hands. They were studying cardiopulmonary bypass in dogs. In examining the hearts after operation, they reasoned that they could implant a heart after leaving in the recipient atria. The operation they described is now used, unmodified, by all surgeons doing heart transplants. Their persistence in this work, when most other programs were halted, is a tribute to their courage and their vision. They kept this field alive long before newer immunosuppressive regimens made this operation commonplace.

One of my own ventures in discovery involved the use of nonhuman organs in clinical transplantation. The time was 1963, more than a quarter century ago, and the place was New Orleans. There was a narrow window in histo-

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Fig. 2. Dr. Voorhees, Jr.

Fig. 3. Dr. Starr.

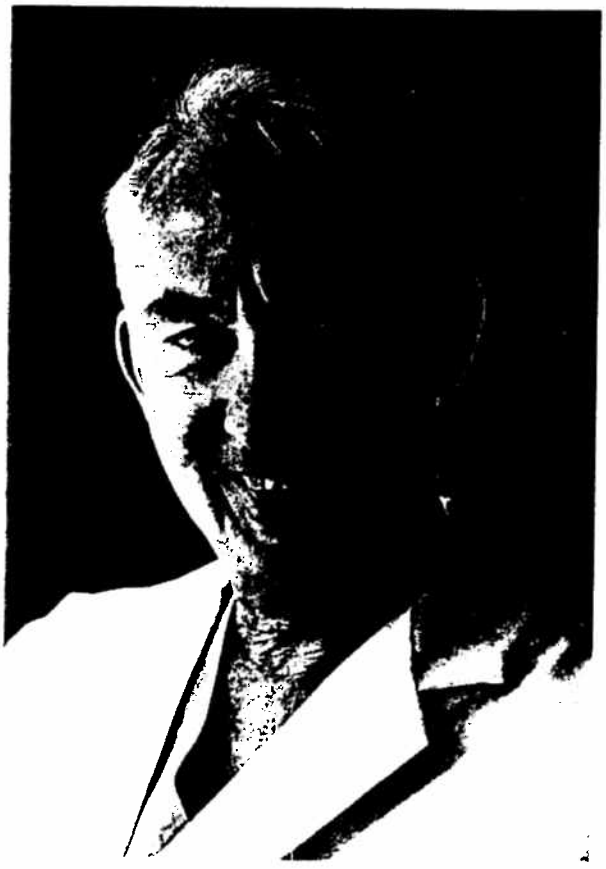

Fig. 4. Dr. Shumway.

after the introduction of the first immunosuppressives but before long-term dialysis or cadaveric transplants were available, when patients with end-stage renal disease without a related donor had no treatment available. I believed that exploration of the use of nonhuman primate donors was ethically acceptable, and patients who received kidneys from chimpanzee donors had courses quite similar to those who received allografts. One patient lived with good renal function for 9 months. When dialysis and cadaveric transplants became available, I discontinued clinical xenografts but have continued laboratory efforts. I believe this field will have a renaissance, and on our program later today we will learn about basic scientific efforts directed toward this end.

As we have reviewed the program of this Association 40 years ago and our program today, we might make some guesses about the program 10 years from now, in the year 2001. It seems certain that we shall be hearing about the extensive use of the artificial heart, considering the remarkable achievements in the past several years with ventricular assist devices, which show much fewer complications than with the prototypes. The development of implantable power sources now seems close at hand.

The application of molecular biologic approaches will make allografting safer and more successful and may permit the use of xenografts, perhaps with specifically engineered species of donors. Such techniques may also provide specific immunologic tools to combat cancer and other diseases.

The application of bioengineering approaches may provide new approaches to the interfaces between living

and prosthetic materials, opening the way to new nonthrombogenic surfaces and the development of various artificial organs. We shall also see the extension and miniaturization of procedures such as endarterectomy.

I would add a cautionary note. I hope that long before the year 2001, surgeons will face questions that society will insist on asking. The questions are not simply what *can* we do, but what *should* we do. When we spread before our people this vast menu of high-technology, high-priced procedures, we should be prepared to ask, and to answer, questions about the cost of this brave new world, and not just in dollars. I would hope that members of our profession would help to understand the value, and not simply the cost, of our work. What about the quality of life? What about the equitable distribution of these resources? If the experience in Oregon, which involves rationing of care, is a forerunner of things to come, and I believe it is, we should be prepared to answer, as citizens and not only as surgeons, the demands of society that we justify our efforts on the basis of their value to us all.

At this point it is customary for the speaker to give you formulas and guidelines and marching orders. That I cannot do. There are certain common denominators that we see in these pioneers, such as vision, diligence, and a willingness to take risks. But the nature of discovery, almost by definition, is largely an individual effort and there is no formula that will guarantee your success. Don't waste your time looking for guidelines in computerized library searches or in old presidential addresses. The key to discovery is locked within each of you. You must look within, into your own experience, your own interests, and your own abilities, to find the secret for success in discovery.

I shall end as I began, with the view that we are somewhere, perhaps midway, in this golden age. It is up to you to decide where we shall go and how long it shall take. But the pleasure and the rewards of discovery come both with the voyage and with the arrival.

We are a blessed group. We do work that we enjoy and society regards this effort highly. Our work is effective, as measured by the improved health of many of our patients. We have the obligation to care for those who are ill, and we have the opportunity to learn and to share.