it must be appreciated that these methods of stimulation are not curative and are effective for only as long as they are applied.

From the considerations presented above it appears that although paired electrical stimulation has profound effects on the electrical, mechanical, and metabolic properties of the myocardium, the most propitious manner in which this technic may be used clinically has not yet been defined. Nonetheless, important steps will have been taken if the physiologist solves the riddle of the mechanism of postextrasystolic potentiation and if the clinical investigator finds a practical way of utilizing the profound changes induced by paired electrical stimulation in the treatment of disturbances of cardiac contraction or rhythm.

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Theory and Fact

I take the view that a theory should be a policy and not a creed, that its most important work is to suggest things which can be tried by experiment, and for this the theory should be one that is easily visualized.—J. J. Thomson.

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Our Common Heritage

Is it of benefit to revive the knowledge of the past? In unfolding the common patrimony which unites successive generations of inquiring men, in meeting them as individuals, in attempting to understand the problems they had to face, the intellectual climate in which their investigations were pursued, and the historical and social conditions under which they lived, it is my belief that a sharper consciousness of our own nature is brought forth, and the continuous doubt of the truths which we are building is revealed as our main motivation.—André Cournot, M.D. Circulation of the Blood. Edited by Alfred P. Fishman, M.D., and Dickinson W. Richards, M.D. New York, Oxford University Press, 1964, p. 62.

Notes for the Lumleian Lecture of April 17, 1616,
by William Harvey

"It is plain from the structure of the heart that the blood is passed continuously through the lungs to the aorta as by two clacks of a water bellows to raise water. It is shown by application of a ligature that the passage of blood is from the arteries into the veins. Whence it follows that the movement of the blood is constantly in a circle, and is brought about by the beat of the heart. It is a question, therefore, whether this is for the sake of nourishment or of heat, the blood cooled by warming the limbs, being in turn warmed by the heart."—William F. Hamilton, M.D., and Dickinson W. Richards, M.D. Circulation of the Blood. Edited by Alfred P. Fishman, M.D., and Dickinson W. Richards, M.D. New York, Oxford University Press, 1964, p. 74.
Summary

Postoperative hemodynamic studies have been performed on 11 subjects following replacement of the mitral valve. In eight cases a comparison was made with the preoperative findings.

The great improvement in the functional capacity of most patients is reflected in the findings of this study, which indicate a small gradient at rest across the prosthesis and no mitral incompetence. The residual gradient was thought to be due mainly to inadequate orificial size, although delay in reaching the fully open position may also play a part.

In two subjects a severely elevated pulmonary vascular resistance fell markedly following the relief of left atrial hypertension.

Two patients failed to show sustained clinical and hemodynamic improvement. In one, mild aortic valve disease was present and severe systemic hypertension developed, resulting in death. The influence of these factors is discussed. In the other, the cause for the continuing heart failure with poor left ventricular contractility was undetermined.

Acknowledgment

We wish to thank our surgical and medical colleagues in the Cardio-Thoracic Surgical Unit and the Cardiac Clinic, Groote Schuur Hospital, for their cooperation and assistance, and in particular Mr. C. C. Goosen for the large part he played in the development of the U.C.T. prosthetic valves and Mr. L. W. Piller and his staff for the technical assistance in the catheterization laboratory procedures.

We also thank Dr. J. G. Burger, Medical Superintendent of Groote Schuur Hospital, for permission to publish details of these cases. Finally, we are grateful to the Council for Scientific and Industrial Research, the City Council of Cape Town and the University of Cape Town for financial assistance. As always, Professor J. H. Louw of the Department of Surgery, University of Cape Town, receives our appreciative thanks for his constant support.

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The Pulse and the Heart Beat

The relations of the pulse to the heart beat, almost entirely neglected by the Hippocratic school, were known in Egypt in the seventeenth and sixteenth centuries B.C., according to the Smith Papyrus. Praxagoras (second half of the third century B.C.), deserves last credit for rescuing this important source of information from oblivion. During his lifetime he witnessed the early stages of the prodigious renaissance of Hellenic medicine, as its center shifted from Cos to Alexandria, and one of his disciples became the chief author of this rebirth.—ANDRÉ COURNAND, M.D. Circulation of the Blood. Edited by Alfred P. Fishman, M.D., and Dickinson W. Richards, M.D. New York, Oxford University Press, 1964, p. 8.
residual gradient, but a lower incidence of the severity of regurgitation, suggests that the optimal gradient reduction may be purchased at the expense of an unavoidable amount of aortic regurgitation. This aortic regurgitation, however, is not necessarily hemodynamically significant.

References

Richard Lower 1631-1690

Lower's dissections of the heart revealed the inner and outer ventricular muscle layers, disposed obliquely, one extending upward toward the right, the other toward the left; the whorl-like conformation around the apex; and the positions of the papillary muscles, holding out the "sail-like" valvular leaflets. About the lesser size of the left auricle, compared with the right, he said: "Hence the (left auricle's) only requisite is, apparently, that a more forceful movement shall be imparted to the blood as it flows past into the left ventricle, and that its passage shall be somewhat assisted. Thus there is no need of the help of so large an auricle on this side."—William F. Hamilton, M.D., and Dickinson W. Richards, M.D. Circulation of the Blood. Edited by Alfred P. Fishman, M.D., and Dickinson W. Richards, M.D. New York, Oxford University Press, 1964, p. 80.


Galena, 131-201 A.D., Founder of Experimental Physiology

Galen, "the Serene," was an intellectual giant. He inherited, discussed, and synthesized all philosophical, scientific, historical, philological, and medical knowledge accumulated during eight centuries of Greek and Hellenistic civilization. His greatest achievement in cardiovascular physiology was his concept of the unidirectional movement of blood and air through the lungs, which endured until Harvey.

He was educated in the foremost philosophical systems of his time, Academic, Lycean, Epicurean, and Stoic, and also in mathematics and logic. Galen's education was strongly influenced by his father, a learned man of the highest personal qualities, and by his city of birth, Pergamon, in which the famous temple to Asklepios was located. At seventeen years of age, apparently prompted by his father's vivid dreams, he added the study of medicine to his study of philosophy. After several years of medical study, which included the dissection of animals, he left Pergamon to travel throughout Greece and Asia Minor, exploring the medical customs of each of the areas that he visited. Included in his itinerary was Alexandria, where he encountered the scientific tradition established by Herophilus and Erasistratos, and where he found human dissection used in anatomical teaching. After twelve years of study abroad, he returned to Pergamon to become physician to the gladiators, a position which provided ample experience in traumatic surgery and medicine. Four years later he moved to Rome, then at the zenith of its power. There he soon achieved great renown for his skills in medical practice and in dissection, and became the physician and friend of the Emperor, Marcus Aurelius. Although his medical colleagues were well aware of his scientific talents and accomplishments, they found his arrogance and ostentation insufferable. His scientific legacy consisted of many papers and books, but no disciples.—André COURNAUD, M.D. Circulation of the Blood. Edited by Alfred P. Fishman, M.D., and Dickinson W. Richards, M.D. New York, Oxford University Press, 1964, pp. 11 and 12.


Galen 131-201 A.D.

An enthusiastic and outstanding investigator during his youth, Galen later became dogmatic and prone to invoke unverifiable forces and teleological concepts in order to explain natural phenomena, and ended by praising Divine Providence for the marvels of its creation. Hence, his authoritative pronouncements in all fields of medicine were readily acceptable to theologians, whether Moslems, Jews, or Christians.—Andre Cournand, M.D. Circulation of the Blood. Edited by Alfred P. Fishman, M.D., and Dickinson W. Richards, M.D. New York, Oxford University Press, 1964, p. 15.


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Quantitative Experiment

Stephen Hales—1677-1761

The Royal Society was also the intellectual environment that stimulated, guided, and encouraged the next contributor of primary importance to the knowledge of the output of the heart, Stephen Hales (1677-1761).

Hales entered Benet (now Corpus Christi) College, Cambridge, at nineteen, took his master's degree seven years later, and in 1711 became a bachelor of divinity. During these years he formed a close friendship with another young man a few years his junior, William Stukeley (the antiquarian who first explored the Druidical mysteries of Stonehenge), and the two young enthusiasts worked together on experiments in anatomy and "chemistry." Hales had the good fortune to receive, as early as 1708, the perpetual curacy of the vicarage of Teddington, a few miles outside London, and he continued his experiments there. For an ordained minister of the church to spend his time in biological experiment was not as strange then as it would be now. This was the eighteenth century, the "Age of Reason based on Faith," and for Stephen Hales at the beginning of the century, just as for Joseph Priestley at its close, the study of Nature was but another way of inquiring into and demonstrating the wisdom of the Almighty; Hales in his writings constantly reminded his readers of this great truth.

DIASTOLIC MURMUR IN AV DEFECTS

Atrioventricular defects was investigated by intracardiac phonocardiography. It was shown to arise at the site of the atrial septal defect, and all other possible causes of such a murmur were excluded.

The production of the murmur depended on the combination of mitral regurgitation and an atrial septal defect of such a size as to permit an interatrial pressure gradient in early diastole.

Acknowledgment

We are grateful to Mr. J. Manders for his skill in obtaining the records that enabled us to do this work. We wish to thank Dr. R. E. Bonham Carter and the physicians of the National Heart Hospital who referred patients for us to investigate.

References


Automation and Happiness

Meanwhile machines deprive us of two things which certainly are important ingredients of human happiness, namely, spontaneity and variety. Machines have their own pace, and their own insistent demands: a man who has an expensive plant must keep it working. The great trouble with the machine, from the point of view of the emotions, is its regularity. And, of course, conversely, the great objection to the emotions, from the point of view of the machine, is their irregularity.—Bertrand Russell, Sceptical Essays (1928).
Blood as a Physico-Chemical System.

Lawrence J. Henderson—1878-1942

The synthesis, the integration of "blood as a physico-chemical system" had still to be done. This was the achievement of Lawrence J. Henderson (1878-1942) of Harvard. After taking his undergraduate and medical degrees there, he visited the chemist Hofmeister in Germany for a brief period; then he returned to Harvard, and began, more or less on his own, an inquiry into the equilibrium between carbon dioxide, carbonic acid, and bicarbonate in water solutions. Great things came from Henderson's contemplation of this apparently simple system. The concept of the acid-base balance in biological systems, hitherto no more than hinted at, took form. It was further developed by many others. Henderson advanced his fundamental idea also into a broader philosophical expression with his essay, The Fitness of the Environment. In a second, The Order of Nature, he pursued the concept of fitness to its logical conclusion and argued for teleology as a positive and necessary tenet in the philosophy of organic mechanism.—André Cournand, M.D. Circulation of the Blood. Edited by Alfred P. Fishman, M.D., and Dickinson W. Richards, M.D. New York, Oxford University Press, 1964, p. 60.
catheterization indicated atrial and ventricular septal defects, with bidirectional shunting. These data, coupled with the clinical data, were considered to favor a diagnosis of complete atrioventricular canal. At the time of surgery, the great vessels were noted to be in normal position, with the pulmonary artery being large and tense, and with no evidence of anomalous pulmonary venous connections. The patient has shown no significant change in her clinical condition in the intervening 2 years, but the parents have been unwilling to proceed with further catheterization studies.

It appears likely that the unusual course of the catheter, due to the venous anomaly, hampered attempts at withdrawal by preventing the application of withdrawal tension in a relatively direct line. Moreover, during attempts at withdrawal, the catheter loop at the azygos-superior vena cava junction was pulled caudally, and this might well have produced an impacting action on the catheter tip rather than withdrawal tension. In other words, instead of the catheter sliding around the junction, the sharp-turn loop may have moved up and down as a unit. Initially, the interference with normal manipulatory "feel" may well have prevented the operator from recognizing the impacted position.

It would seem advisable to anticipate the possibility of this complication in patients catheterized by way of an anomalous inferior vena cava with azygos continuation. Moreover, it may well be more difficult to withdraw a catheter tip from a wedged pulmonary artery position in patients who have been catheterized by way of this anomalous vein. Cardiac catheterization is more difficult to carry out by this route, aside from this complication; so if this anomaly is suspected, an arm or axillary vein should be used.

**Summary**

A complication of right heart catheterization is described in which the tip of the catheter became impacted in a vein connecting to the coronary sinus, requiring thoracotomy and removal under direct vision. This occurred in a 2-year-old patient with an anomalous inferior vena cava with azygos continuation, and it is suggested that this anomalous course may well have contributed to the development of this complication.

**References**


**Arteries, Veins, and the Movement of Blood**

Alcmeon of Croton, the first Greek known to have practiced dissection, distinguished two types of vessels (phlebos) carrying blood, as early as the sixth century B.C. This member of the Pythagorean sect, primarily interested in the relationship between the brain and the sense organs, taught that, during sleep, blood retrograded from one set of vessels. Having observed the vacuity of some vessels after death, he assumed that in similar fashion the same vessels became bloodless during sleep.

The separation of vessels into two types is found early in the Hippocratic Corpus (fifth century B.C.). At first the term "artery" was used to designate the trachea and bronchi, which transported pneuma to the heart. Since some of the vessels originating from the heart cavity were found more or less empty of blood after death, they too were soon called arteries; but they were also said to transport blood and to be connected with the veins.—André Cournand, M.D. *Circulation of the Blood*. Edited by Alfred P. Fishman, M.D., and Dickinson W. Richards, M.D. New York, Oxford University Press, 1964, p. 4.
CONGENITAL HEART DISEASE

is another factor contributing to the appearance of stasis in the brain.

These changes in the brain taking their origin from the malformation of the heart are concurrent with cardiac changes as the cause of death and often appear in advance of them.

The authentic, dynamic picture of changes occurring in the organs in congenital heart disease we have presented prompts this principal practical conclusion: the surgical operation should be undertaken in early childhood, when severe disturbances have not yet developed in the heart, the lungs, and the brain.

A correct understanding of the essence of the phenomena observed at the patient's bedside is impossible without gaining a clear idea of their material substrate. It should be borne in mind, at the same time, that the most severe changes of the heart, lungs, and brain develop in subjects with congenital heart disease having a decreased blood flow in the lungs and cyanosis. Therefore, we consider that an early operation is indicated; above all, for patients with stenosis of the arterial conus of the right or the left ventricle, inasmuch as they early develop severe disturbances in the heart, the lungs, and the brain. Patients of equal age (i.e., with equal terms of disease), for example, those with isolated defects of the atrial or the ventricular septum, have these changes to a negligible degree; therefore, they can wait for an operation longer than those with Fallot's tetralogy, pentad, and triad, as well as with congenital stenosis of the arterial conus of the left ventricle.

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