ON RUNDS

Remembering William Harvey: Discoverer of the Circulation of Blood

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Introduction

By most accounts, William Harvey was a small, nervous man with an unusually large head. Perhaps it was his receding hairline and resulting broad forehead that made his cranium seem of the 'cerebral' type. (See Figure 1) His appearance notwithstanding, this eldest son of an English merchant would, in the prime of this career, unravel the true facts concerning the heart and circulatory system. His investigations and writings, though slow to gain acceptance, would ultimately dismiss the teachings of such great philosophers as Aristotle and Galen. And though more than three centuries have past since his death, Harvey's fame continues to grow as today's scholars and medical practitioners re-discover and re-examine his remarkable teachings and conclusions.

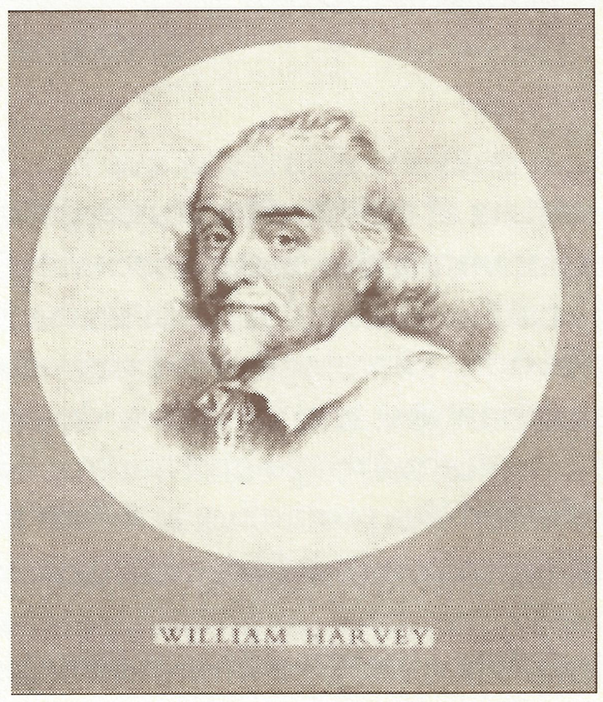

Figure 1
Engraving by C.H. Jeens in 1878 from portrait of William Harvey (age 72) displayed in the library of the Royal College of Physicians, London (reprinted with permission: The Scientific Book Guild, London, England).

Adolescent Years

William Harvey was born on the 1st day of April, 1578, in the little town of Folkestone (a community not far from present day London, England). The name Harvey is believed to be French in origin, with variant spellings such as Herve', Hervey, and Hervier. Little is know of Harvey's mother, except that she died in 1605. Harvey's father, while a simple merchant, was reputed to be a man of considerable intelligence and served as mayor of Folkestone in the year 1600. Harvey had two sisters and six brothers. As a youngster, Harvey displayed a lively curiosity for how things worked. His desire to study and learn prompted his parents to send him to King's Grammar School in Canterbury at the age of ten. At the beginning of his sixteenth year, 1593, Harvey entered Gonville & Caius College in Cambridge. His coursework was predominantly Latin and Greek studies, although he did receive instruction in natural science (what little was known of it at the time). In 1597 he graduated with a Bachelor of Arts degree.

Padua University

Harvey furthered his education by enrolling at Padua University in 1599. Padua, a prestigious Italian academy, was *the* medical university in Europe at the time. Virtually all university curriculums of the Renaissance era adhered strictly to the teachings of Aristotle, and Padua was no exception. However, since the early fifteenth century, Padua had been ruled by Venice, perhaps the most anticlerical city in Europe. So whereas most of the universities taught a highly christianized version of Aristotelianism as a preliminary to theology, Padua taught the doctrines of Aristotle as a preliminary to medicine. This resulting freedom of thought attracted many of the ablest men of the time – among them Versalius, Copernicus, and Galileo. Harvey graduated from Padua in the spring of 1602 with his doctorate, and returned to his native England to begin practicing medicine at St. Bartholomew's Hospital in London.

Arm Veins

The presence of valves in the arm veins was first described by Sylvius at the beginning of the 16th century. A master anatomist from Paris, Sylvius had a cantankerous disposition and would often retreat to his laboratory for days, speaking to no one. As such, most of his work fell into oblivion. In 1574, Fabricius 're-discovered' the valves and quickly assumed official credit for their description. Unfortunately, Fabricius did not deduce the correct conclusion regarding the valves. That being, that in view of the arrangement of the valves in the veins, the blood could travel in one direction only – towards the heart. Fabricius had been schooled in the teachings of Claudius Galenus (known as Galen). For nearly fourteen centuries, the beliefs of Galen, a second-century Greek phy-

sician, were held sacred. He believed, for instance, that the center of the blood system was the liver, and that blood flowed in all directions from it. Alas, this explains why Fabricius missed the point entirely regarding the valves in the arm veins. He simply held to the Galenic doctrine that blood 'ebbed and flowed' in all directions, daring not to consider that it might be otherwise. Harvey studied under Fabricius at Padua, and considered him a mentor. However, Harvey's ensuing work at St. Bartholomew's Hospital would call into question the long-held beliefs of Aristotle, Galen, Fabricius, Versalius, and others. Ultimately, Harvey would prove them wrong - all of them.

Circulation

Harvey's anatomical curiosity knew no bounds. He often visited the market and purchased newly caught fish still squirming and wriggling about. Through an opened thorax he viewed the last spasms of these creatures' lungs (gills), hearts, and circulatory systems. He dissected human cadavers, as well as living dogs, pigs, snakes, frogs, lobsters, insects, and even oysters. By 1616, Harvey was convinced that Galen's theory of the circulation was wrong. (See Figure 2) For starters, Galen believed that the arterial and venous systems were quite separate, and that the blood 'ebbed and flowed' in each. Second, Galen believed that minute pores in the septum between the two halves of the heart allowed venous and arterial blood to mix. Third, he believed that the lungs were merely bellows used to force air into the left side of the heart. And finally, Galen postulated that the heart imparted movement to the blood during the diastolic or 'filling' phase. Specifically, this was accomplished by serial contractions and relaxations of the major arteries that magically 'sucked' blood from the heart. How remarkable that for centuries no man dared to question these erroneous beliefs. How remarkable that blind faith and fear could fetter and obstruct the advancement of knowledge for so long. And yet, how fortunate that William Harvey, the son of an English merchant, would stand up to his critics and make his anatomical conclusions known.

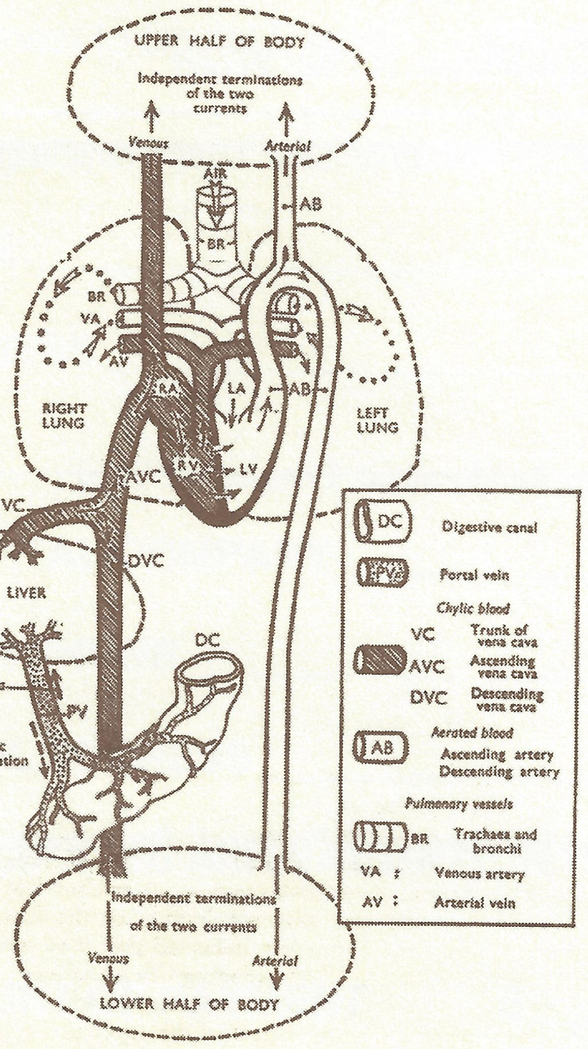

Figure 2
Galen's theory of the circulatory system. Note the perforations between the right and left ventricles, and separation of the arterial and venous systems (reprinted with permission: The Scientific Book Guild, London, England).

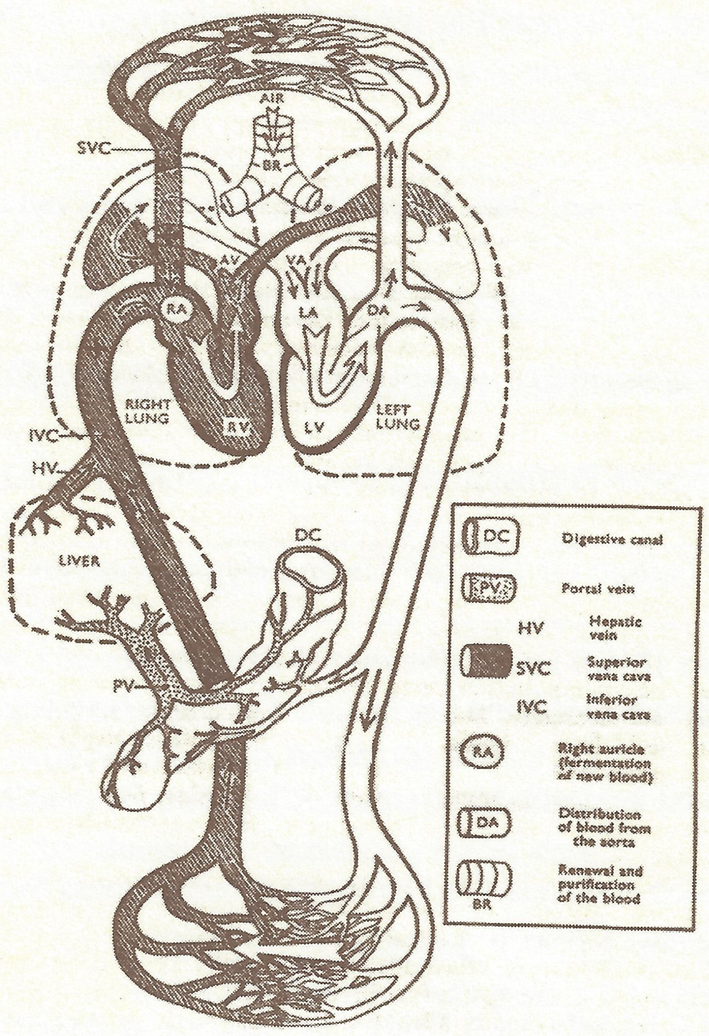

Figure 3
The circulatory system as taught by William Harvey in the 17th century (reprinted with permission: The Scientific Book Guild, London, England).

De Motu Cordis

Regarding the heart and circulatory system, Harvey had arrived at his conclusions before he reached the age of forty. He began explaining his views in lectures to the Royal College of Physicians in 1619, and was no doubt putting them into practice at St. Bartholomew's Hospital. For over a decade he made nothing public. Then in 1628, Harvey published his masterpiece entitled *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus.* Though just seventy-two pages in length, this text, published in Frankfurt, depicted the heart and circulation in their correct anatomical and physiological form. (See Figure 3) In 1649, Harvey published two follow-up letters further explaining his research, beliefs, and teachings. By 1670, his description of the heart and circulatory system was almost universally accepted, and not a single Galenic anatomist could be found in any European center of learning.

Continued on Page 12

are the basis for our clinical decisions." Therefore "the ultimate goal of EBM is the delivery of information in a manner that addresses the so called "gap" between recommended and actual practice." This gap is readily apparent in perfusion practice. A concern of this working group continues to be the phenomenon of perfusionists attending high quality clinical meetings, gaining important clinical knowledge, yet making no changes in their management of patients on bypass. At a recent one-day symposium on best practice perfusion, a survey was held to gain insight into standard practices by perfusionists. Despite the recurrent emphasis at meetings over the last several years regarding prime volume, biocompatible surface coatings, field suction and overall neurologic protection, the following profile presented: 1) 45% responded to still have a prime volume of 1.5 to 2 liters, 2) 48% responded glucose is not treated until >200mg/dl, 3) 99% responded field blood is returned to the perfusion circuit, 4) 56% responded they feel their program transfuses PRBC too often, 5) 48% responded to no use of a biocompatible technology. This survey model will continue as our group presents at different venues in the future. As such, the evidence-based practice follows a two-pronged approach; the scientific literature is appraised and validated, then the analysis of the literature or evidence is disseminated. To this end, the Best Practice Perfusion Group has begun this journey. We fully recognize that it is not our intent to force blind adherence to a set of guidelines. Rather we seek to provide the tools necessary to facilitate an assurance of seeking best practice for every patient and enhancing overall outcomes.

Best Practice Perfusion Group: Initiative II

Professional Practice - It is entirely fruitless for a perfusionist to embark on changing their practice or techniques and technology in a vacuum. No net effect in outcome improvement will come by decreasing a prime volume, utilizing a reduced surface area circuit with some form of biocompatibility and avoiding transfusion in the operating room if the anesthesia team you are working with routinely administers 3000 ml of crystalloid pre-bypass, the surgeon you are working with demands to send all field blood the circuit, and the ICU has no formal transfusion algorithm to follow. Therefore, it is the reason we seek to engage our peers to initiate a higher level of professional practice. To effect such change, perfusionists must be involved clinically and institutionally more than ever before. It is critical for perfusion departments to support staff involvement in surgical morbidity and mortality conferences, transfusion committees, quality assurance committees, JCAHO compliance and the like. To not be involved as allied health professionals will result in the failure to seed a secure future as an allied health professional. Through critical analysis and thoughtful interaction with anesthesiologists, surgeons and administrators, the path to effecting change will become attainable. A focus must be placed on the education of future perfusionists, not merely in clinical practice, but in professional practice. Students must enter the surgical arena with a desire to move forward professionally. Emphasis should be placed on basic perfusion research, attaining licensure, developing improved technology and techniques with value being associated publicly to our profession. Only from this point will we be able to effectively turn back the tide of extracorporeal circulation being associated as having such a negative impact on patients. In the majority of the literature debating which approach of coronary revascularization is better, on or off bypass, cardiopulmonary bypass is only referred to as "standard CPB" or "conventional CPB". The playing field is not level in this debate. The Best Practice Perfusion Group is thus advocating that standard CPB in effect means current best practice in both technique and technology, thereby creating a platform to support the safety and efficacy of extracorporeal circulation.

As stated, this is just the beginning. We look forward to increasing numbers of involved individuals contributing to this process. We are planning to publish consensus guidelines in clinical journals, present at meetings, hospitals and training programs. The topics will also continue to evolve and we look forward to providing the current evidence on whatever topic we are asked to or deem relevant at the time. We eagerly await phone calls to assist individual perfusionists and or perfusion teams in effecting positive change and move towards greater professional involvement. Please do not hesitate in contacting us.

Continued from Page 7

Final Days

William Harvey officially retired from practicing medicine sometime around 1650. Throughout his life he battled gout, and in 1657 he suffered a debilitating stroke. He subsequently was confined to a room in his brother Eliab's house in the country near Roehampton, England. He was able to view the countryside through a window, but was unable to speak. On the 3rd day of June, 1657, William Harvey died, the author of the most significant and celebrated discovery ever made in physiology. He was buried in Hempstead, England, some fifty miles to the northeast of London. A stone beneath his tomb and bust in the small Hempstead Church reads, *"William Harvey, at the mention of whose honorable name all academies rise up out of respect, who was the first after many thousand years to discover the circulation of the blood, and so brought health to the world, and immortality to himself."*

References

1. The Heart. Longmore D. World University Library. London 1971.

2. William Harvey: His Life and Times, His Discoveries, His Methods. Chauvois L. Scientific Book Guild 1961.

3. Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus. The Keynes English Translation of 1928. Classics of Medicine Library. Birmingham 1978.