Middle Articles

Boerhaave after Three Hundred Years

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The tercentenary next week of the birth of the man who was long known as "the Dutch Hippocrates" would in itself warrant some notice in the *British Medical Journal*, for it is to him that we owe the scheme of medical teaching that was first put into operation in this country at Edinburgh, and it is that scheme, with extensions and modifications, that applies in our medical schools today. Boerhaave's fame, transcendent in his lifetime and long after his death, has tended to wane greatly during the last hundred years. Perhaps this was inevitable, for no one had written anything about his life for over two centuries, and studies of his work were written mainly by specialists for specialists. Now that Professor G. A. Lindeboom, of Amsterdam, has remedied this defect by the publication of a study in depth, there will be an increase in interest in Boerhaave and his work.† In this tribute, therefore, I also take the opportunity of discussing briefly some of the reasons why Boerhaave's real importance tended to be misunderstood from about the middle of the nineteenth century—a subject that is rather outside the scope of Professor Lindeboom's book. (No references are given to biographical statements in this note, as they are all readily available in the book. References are, however, given to matters not dealt with in it.)

Herman Boerhaave. Portrait in chalks of *c.* 1725 by Jan Wandelaar. (In the possession of the Medical and Pharmaceutical Museum at Amsterdam.)

Early Life

Herman Boerhaave was born on 31 December 1668 in the parsonage at Voorhout near Leiden. His father, Jacobus Boerhaave, the local minister of the Dutch Reformed Church, was a learned man, and he taught his son Latin, Greek, and history. But he died when Herman was aged 15 years, and his widow was left with the care of nine children, of whom Herman was the eldest.

After education at the grammar school Boerhaave entered the University of Leiden in 1684 with the intention of becoming a minister. He studied philosophy (including natural philosophy) and divinity, and continued with his classical studies. After six years of study he graduated as a doctor of philosophy at Leiden. He next combined his study of divinity with a supervisory post in the university library. But meanwhile he had decided that he would also graduate in medicine. This ought to have involved attendance at medical lectures, but Boerhaave was determined to study privately. He first read the works of the great anatomists, and supplemented this by attending some of the dissections of Anton Nuck. He had previously started chemical experiments, and he now received some lessons in chemistry from a distinguished visiting chemist. He then proceeded with the study of the medical writers proper, beginning with Hippocrates and ending with Sydenham. It is quite certain that Boerhaave never attended a formal lecture by any professor in the Medical Faculty at Leiden. When he considered that he had completetd his studies, he wrote a thesis and presented it successfully for his M.D. degree—not at Leiden, but at the University of Harderwick, where he graduated on 15 July 1693. He had studied at the University of Leiden for nearly ten years.

As a result of an unfortunate occurrence shortly after his graduation Boerhaave was —quite unjustly—suspected of Spinozism. This suspicion effectively precluded a career in the church. Boerhaave therefore started to practise as a physician at Leiden, supplementing his income by teaching mathematics, and continuing his intensive medical studies and chemical experiments.

Charles Drélincourt, who taught the Institutes of Medicine, died in 1697. Prolonged negotiations failed to find a distinguished successor, and in 1701 the university appointed Boerhaave as "lector"—that is, reader—in medicine to carry

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† *Herman Boerhaave, The Man and his Work*, by G. A. Lindeboom, M.D., Professor of Internal Medicine in the Free Reformed University of Amsterdam. London. 1968. The book is reviewed at p. 817 of this issue.

on Drélincourt's professorial work at a much smaller salary. From the beginning Boerhaave's lectures were a great success. Under the title of the Institutes he included physiology, general pathology, and an introduction to symptomatology and therapeutics. Within a year the students requested him to give also private lectures in anatomy and chemistry, and the university granted permission. Boerhaave's teaching of anatomy did not last long, but he was to teach chemistry continuously for the long period of twenty-seven years. During his eight years as a "lector" he had some tempting offers from other universities, and quite early the Curators promised him the first vacant chair in the medical faculty provided that he would consult them about any such offers.

Towards the close of his period as a reader in the university Boerhaave published two books which were to be very influential. His *Institutes (Institutiones medicae)* was published in the autumn of 1707 (though dated 1708); and his *Aphorisms concerning the Knowledge and Cure of Diseases (Aphorismi de cognoscendis et curandis morbis)* was published in the autumn of 1708 (though dated 1709). Both books were a success from their first appearance.

Professor at Leiden

The professor of medicine and botany died on 10 January 1709, and on 18 February the Curators appointed Boerhaave to this combined chair. The decision was difficult because Boerhaave had never taught botany, and in fact he had done no work at all in that subject since his private studies ten years previously. Further, the occupant of this chair was also ex officio "praefectus horti," the director of the university botanic garden. However, Boerhaave's capacity for work enabled him to overcome the difficulties. He used to lecture on botany at 7 o'clock in the morning from February to July, each lecture lasting two hours. In addition he continued his official lectures on the theory of medicine, and as a consultant he was becoming well known.

Boerhaave immediately began to prepare a catalogue of the Garden, and the resulting small volume was published in 1710. He considered this book essential for his work on the "commercium"—that is, his voluminous correspondence with foreign botanists regarding the exchange of plants. Under his direction the Garden rapidly became overcrowded with new plants, and there were repeated requests for its extension.

The teaching of clinical medicine had been carried on at Leiden since 1637, but it had seldom been popular with the professors and there had been periods when there was no teaching at all. On the death of Govert Bidloo in 1713 the Curators reconsidered this question. They decided to ask Boerhaave to take on this additional work, and in 1714 he was appointed professor of clinical medicine. He shared the work with the ageing Frederik Dekkers, but Boerhaave was responsible for the greatly increased enthusiasm for this subject. Two wards, one for men and one for women, each of six beds, were reserved at the St. Caecilia Hospital for teaching purposes. For the rest of his life Boerhaave taught there twice a week, and the superb quality of his teaching is shown by the notes of his lectures kept by himself and his students, by the comments of visitors to the demonstrations, and by the large numbers of students from many countries who enrolled for the courses.

In 1718 the death took place of Jacobus Le Mort, the professor of chemistry. During the whole of Le Mort's professorship Boerhaave had, with the full approval of the authorities, been giving private lectures in chemistry. The choice of Le Mort's successor was obvious, and in 1718 Boerhaave was appointed professor of chemistry in addition to his other duties. He still continued with his remunerative private lectures, and he now had for his own experimental work the use of the university chemical laboratory.

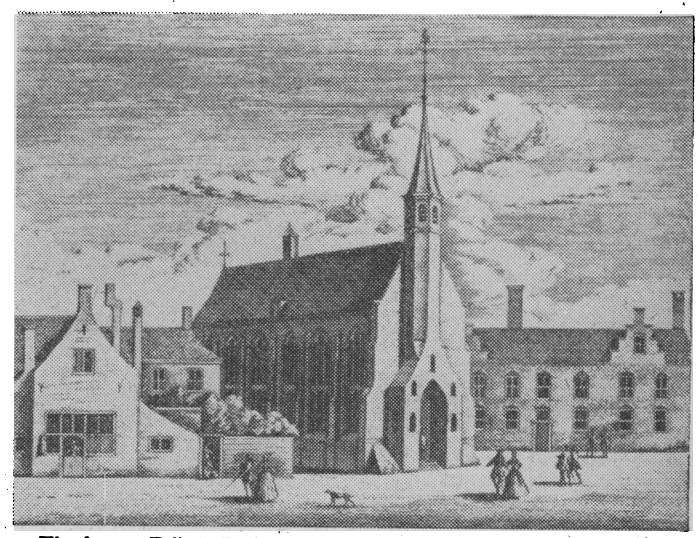
The years that followed showed Boerhaave at the height of his powers. Year after year he continued to fulfil the duties of three separate chairs, and his private consulting clientele included many European notabilities. He rose long before dawn and organized his day very rigorously. He could restrict his journeys for consultations to a comparatively small area round Leiden, since rich patients were always willing to come to him. As the years passed he also became involved in the production of costly and important works of scholarship. But he had had fairly serious illnesses in 1722 and in 1727, and, despite a rigorous selection of patients and suspension of his consulting practice for long periods in the summer, the demands of that practice were insistent. In 1729, therefore, Boerhaave retired from two of his three chairs—those of botany and chemistry. It is still sometimes stated that in 1729 he resigned from all his teaching duties, but this statement is quite erroneous. Until his death Boerhaave continued to occupy the chair of medicine, and to lecture on the Institutes and on practical and clinical medicine. Some of the lectures delivered just before his last illness contain important observations.

On 14 September 1710 Boerhaave married Maria Drolenvaux, the only child of a wealthy merchant. The marriage was a very happy one. Their eldest child, Joanna Maria, born in 1712, married Frederik, Count de Thoms. The Boerhaaves had three other children, all of whom died young. They resided in the official residence of the professor of botany, and when Boerhaave retired from that chair twenty years later he purchased a handsome residence in the city. But in 1724 he had also purchased a historic mansion and estate—"Oud-Poelgeest"—a few miles from Leiden. There he spent his weekends and entertained visiting notabilities, and its vast garden he transformed into one of the botanical sights of Europe.

Towards the end of 1737 Boerhaave began to suffer from dyspnoea, and by April 1738 his condition had become serious. Anasarca and oedema of his feet and legs rapidly developed, and he died in the early morning of 23 September 1738. He was buried in the Pieterskerk at Leiden. Boerhaave died a very wealthy man.

Boerhaave as a Scientist

In botany Boerhaave is notable for four activities. Firstly, he almost doubled the number of plants in the Garden. In 1720 he published a greatly extended second edition of his catalogue of the plants, a very valuable work. In this Garden he gave for twenty years systematic instruction in botany. Secondly, he was the first to introduce a really practical hothouse stove, and by its aid he cultivated many tropical plants.

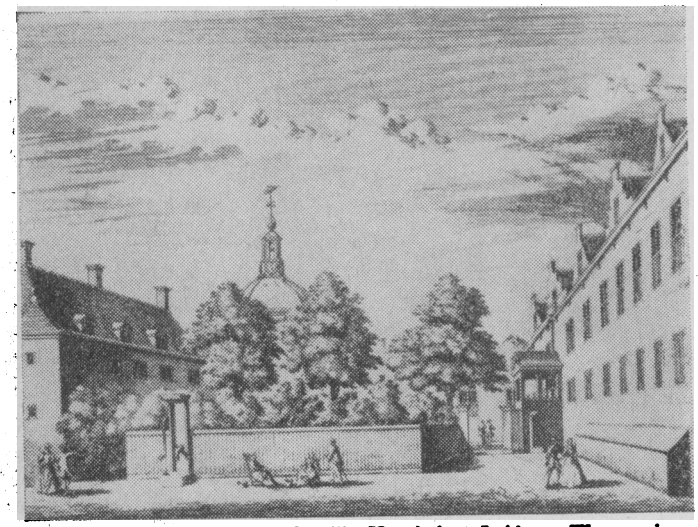


The former Faliede Bagijnen Church at Leiden, which in Boerhaave's time housed the university anatomical theatre. Engraved by A. Rademaker c. 1730.

Thirdy, he published at great personal expense the sumptuous *Botanicon Parisiense* of his departed friend Sébastien Vaillant, and thus advanced knowledge of the plants of northern France. Fourthly, by his unwearying correspondence with botanists in other countries, by his exchange of plants, and by his assistance to and encouragement of young botanists, he stimulated the development of botany as a science. In his young days Linnaeus was greatly indebted to Boerhaave for his recognition of the fact that a new synthesis and classification was required, and that possibly Linnaeus was the man to carry it out.

For an exact conception of Boerhaave's importance as a scientist one has to turn to his experimental work in chemistry. Apart from an important inaugural oration he published nothing on this subject until 1732, when his great textbook, *Elementa chemiae*, was published in two large volumes. He had been teaching the subject very successfully since 1702, and the development of his ideas and results can be traced in the successive collections of surviving notes made by his students. An unauthorized edition of these notes, published in Latin surreptitiously in 1724, was very successful and was translated into several languages. This work greatly annoyed Boerhaave because of its supposed inaccuracies. His own book was also translated into many languages. The first volume dealt with physical and inorganic chemistry and was especially influential on the work of succeeding French chemists, including Lavoisier. The second volume dealt with the chemistry of vegetable, animal, and mineral substances, and with the practical experiments that Boerhaave used at his demonstrations. This volume was particularly valuable to the German chemists of the next fifty years. Through the much-prized notes made by his students, and through his own textbook, Boerhaave's influence in chemistry extended from 1702 to 1791, the date of the last German translation of his second volume.[1]

Detailed discussion of the contents of the *Elementa* can be found elsewhere,[2] and this account must be confined to a brief summary of Boerhaave's importance in chemistry. He was the first chemist to insist on the strict application of the Newtonian principles to chemical experiments, with the consequence that his experimental results showed a hitherto unknown degree of accuracy. By the use of the thermometers made for him by his friend Fahrenheit he gave exact temperatures for the reactions that he studied, and this exactness was something quite new in experimental chemistry. He righly held that if under known conditions of temperature and pressure he obtained a certain reaction he would always be able to obtain the same result under identical conditions. His aim was to raise chemistry to the position of an exact science comparable to Newtonian physics, and he was really the founder of quantitative chemistry. Before his time the "matter of fire"—that is, heat—was considered as one of the elements and that it had weight. Boerhaave showed that when a given mass of iron is heated it expands, but that its weight remains unaltered. He was the first to study the degrees of heat or cold produced by the solution or mixing of various substances. He laid down very strict general rules for the conduct of all experiments.



The courtyard of the St. Caesilia Hospital at Leiden. The wards in which Boerhaave taught are on the first floor of the building on the right. Engraved by A. Rademaker *c.* 1730.

Though Boerhaave made no mention of the phlogiston theory, his hypothetical "pabulum ignis," supposed to be present in combustible bodies, is similar to phlogiston. But he seemed to have been convinced that there was in the atmosphere an unknown substance that was necessary for combustion. He distinguished clearly between mechanical mixtures and chemical compounds. In this respect he introduced the modern view of chemical affinity, that it is greatest between bodies of unlike natures.

In his experiments and demonstrations on animal and vegetable substances Boerhaave passed into a field that was virtually uncultivated. He carried out experiments on milk that controverted ideas then current, and he also did experimental work on urine, blood, egg albumen, and other organic substances. It was not until 1878 that Van't Hoff noticed that Boerhaave had described in his *Elementa* his discovery of a substance that was almost certainly urea.[3] This was at least 45 years earlier than the date usually given for its independent discovery by Rouelle. Van't Hoff's suggestion passed virtually unnoticed until 1943, when Backer repeated Boerhaave's experiment—which required a year to carry out—and obtained Boerhaave's result.[4] Boerhaave showed by pharmacological experiment that his product—the "sal nativus urinae," the natural salt of urine—had diuretic and diaphoretic properties. Boerhaave also carried out very important experiments on fermentation, in which he distinguished fermentation from putrefaction and differentiated between vinous and acetous fermentation. No further important work on this subject was done until the time of Pasteur.

All this, and much more, is in the *Elementa chemiae*. But there were certain experiments that he did not describe adequately in that work, for the reason that he had not completed them. Chemistry was at that time still suffering from the alchemical belief in the transmutation of metals. Boerhaave, whose chief aim was to raise chemistry to the status of Newtonian science, saw quite early in his career that the alchemical beliefs ought to be shattered by exact experiment, and he set out to do so. These experiments started in 1718 and were continued until about 1735. They were published in Latin in three parts in the *Philosophical Transactions* of the Royal Society, of which he was a Fellow, between 1734 and 1736. In one experiment he heated a quantity of pure mercury continuously for over 15 years, and after the small quantity of black powder on the remaining mercury had been reduced the whole of the original mercury was recovered. In another experiment mercury was distilled with gold 877 times. As a result of very numerous experiments he was unable to confirm any of the claims of the alchemists. Further, he produced several substances which he tried out therapeutically. Finally, as a result of a fractional distillation of mercury carried out 511 times he found that the specific gravity of the mercury had increased. These experiments were carried out with the utmost precision and with the best instruments. They were re-examined in recent years and the claim was made by a distinguished chemist that by this laborious method Boerhaave had produced a heavy isotope of mercury. It should be mentioned that Boerhaave kept in his private collection most of the actual materials on which he had performed experiments, all labelled with brief details of the process. After his death this collection formed a very important sale, of which a unique copy of the catalogue has survived, but without the names of the purchasers. It would have been vastly interesting to have ascertained by a modern process whether Boerhaave did indeed produce an isotope of mercury.

Boerhaave as Physician and Teacher

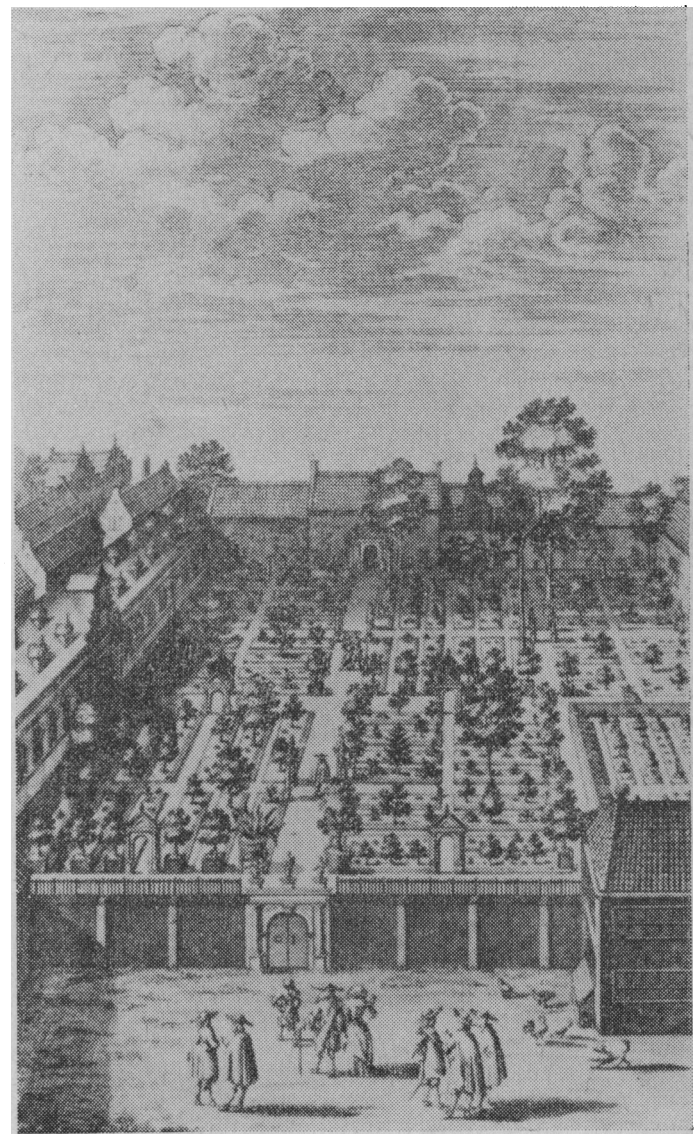
In a brief tribute it is impracticable to attempt any assessment of the contents of Boerhaave's teaching of the Institutes. He lived at a time when new discoveries were changing the direction of research on the functions of the organs of the body. But these individual discoveries had not gone very far, and there was in existence a corpus of knowledge that had been long accepted. As a teacher Boerhaave considered that it was his duty to integrate the new knowledge into the old, and thus arose his two books written for the use of students, the *Institutes* and the *Aphorisms*. But it should not be assumed that the contents of these books represented his lectures. Written in concise form, in numbered paragraphs or aphorisms, the contents were used by Boerhaave as headings for his lectures. At each lecture he would take a few paragraphs or aphorisms, expound his meaning more fully, and introduce recent work or his own second thoughts. The results of this process can be traced in the subsequent editions of these two works, and more especially in the editions of his lectures published later by his former pupils, particularly Albrecht von Haller and Gerard van Swieten. The aftermath of the discoveries of Harvey and of Leeuwenhoek gave Boerhaave, and most other physiological writers, grave problems. For example, the mere accident that it was customary to dilute blood with a little water before examining it microscopically gave rise to haemolysis, about which these investigators knew nothing. The resulting disintegration of the red cell led to a complex theory of non-existent blood elements of descending magnitude, and ipso facto to a conception of hypothetical channels in size appropriate to the sizes of the various blood elements. In the realm of digestion Boerhaave himself carried out experiments which, though not revolutionary, had their place in the knowledge of his time.

In the clinical field Boerhaave made no discovery to which his name could easily be attached eponymously. He was the first to describe a spontaneous rupture of the oesophagus, and his description of that case is complete and dramatic.[5] He made one very important innovation—the introduction of clinical thermometry into medicine. It is strange that he did not record more observations in this field; but his pupil, Anton De Haen, carried that art to Vienna and later greatly outdistanced his master in it. Boerhaave had very sane views on treatment. His prescriptions show little trace of polypharmacy, and the ingredients were used for their pharmacological action as known at that time. He was the author of a small book, *Libellus de materie medica*, which set out clearly for the use of his students those remedies that he had found valuable. But his therapy embraced a good deal of practical psychology, as well as precise instructions on diet and physical therapy—massage, exercise, baths, and other measures. In his private consulting practice Boerhaave often saw between 40 and 50 patients a day, and his written consultations, sent by him to correspondents and his former students all over Europe, were very numerous.

Some Misconceptions

Few great medical men have suffered so much as Boerhaave from excessive adulation on the one hand and from partial knowledge on the other. One example that springs to mind is the following. In 1900 Sir Clifford Allbutt, then regius professor of physic at Cambridge and a very distinguished scholar, wrote for the *British Medical Journal*, at its editor's request, a long article on "Medicine in 1800."[6] In this article Allbutt criticized Boerhaave very severely. "Perhaps no physician," he says, "ever enjoyed so great a fashion with so little scientific merit." Even in his clinical teaching "Boerhaave showed less insight and skill than his pupil Van Swieten." (Here Allbutt overlooks the fact that much of Van Swieten's *Commentaries on the Aphorisms* were Boerhaave's own words, taken down in shorthand by Van Swieten.) Boerhaave, Allbutt says, "seems to have made no experiments, and, in his writings at any rate, to have contented himself with hashing up the partial truths and the entire errors of his time." There is no mention in this paper of Boerhaave's chemistry and other scientific work.

These were harsh words. Seventeen years later Sir William Osler, then nearing the end of his life and his regius chair at Oxford, delivered at the Royal Society of Medicine a paper on "Boerhaave's position in science." (This paper he never published, and it remained unknown until it was rescued from oblivion by Professor Lindeboom.[7]) In this paper Osler castigated his Cambridge "brother regius" for his "astonishing statement" that Boerhaave made no experiments in medicine. Osler rightly saw that Boerhaave's experimental work lay in the chemical field, and he noted a very few of the advances published in the *Elementa*. But he does not appear to have had any detailed knowledge of the importance of this work, and his comments on Boerhaave's clinical writings are unworthy of Osler as a historian.[8] It is possible that Osler intentionally decided against the publication of this paper. Allbutt on the other hand had no second thoughts, for he republished his paper of 1900 twenty-one years after its first publication.[9] But much may be forgiven in a man of 85.



The Physic Garden of the University of Leiden. Engraved by C. Hagen, 1670.

Somewhat surprised and dismayed by such assessments, I was interested to find out what the great historians of medicine of the last few generations, read consecutively as a whole, had had to say about Boerhaave and his work. My brief search, extending from Wunderlich (1859) to about the time of the first world war, has disclosed amazing inaccuracies and inconsistencies. Errors in biographical facts are very noticeable, and it is noteworthy that there is no agreement on the question whether Boerhaave did, or did not, found a "system" in the sense in which Hoffmann did. All these works base their comments on Boerhaave's views solely on the *Institutes* and the *Aphorisms*. This would have annoyed Boerhaave very much, for he expressly emphasized that these were compilations for the use of students, and were to be used as adjuncts to, and not as substitutes for, his lectures. Although the great Haeser does mention the title of Boerhaave's book on chemistry, neither he nor any other of these historians makes any detailed reference to Boerhaave's chemical experiments. In the largest of these historical works, Puschmann's *Handbuch*, adequate reference is made in various places to some aspects of Boerhaave's work, but in the section of 16 pages devoted entirely to medical chemistry his name is not even mentioned. Nearly all these works state or imply that Boerhaave's fame was due to his personality, his gifts as a teacher, and his brilliant students. I have traced this attitude back to Charles Daremberg (1870), who stated it very clearly. He said that he was unable to explain the universal enthusiasm for Boerhaave on the basis of his writings, "même par ses deux ouvrages réputés classiques"—namely, the *Institutes* and the *Aphorisms*. He then proceeded to discuss these two students' textbooks in some detail. Of the *Elementa* and Boerhaave's chemical experiments there is not a word.[10]

The irony is that all these misconceptions—though not the errors—could have been avoided. Long after Boerhaave's own day it was clearly recognized that what he taught was "medicine" in its broadest sense, embracing botany (the study of natural drugs and their origins), chemistry (and especially the chemistry of the animal body), physiology, general and special pathology, semeiotics, diagnosis, and therapy. Research in any one of these fields was still medical research. Although Boerhaave occasionally did experimental research in physiology, by far the greater part of his research activities were devoted to chemistry. His pupils had a complete understanding of his aims and views. That they greatly profited by his experimental methods and example can be shown from the writings of Haller and others.

Literary Work

I have not mentioned in this tribute other medical and scientific works by Boerhaave, but it would be very unfair to omit reference to his costly labours in relation to the work of other men. Early in his career he edited the works of Eustachius and others, and later on he re-edited and published at his own expense sumptuous editions of the works of Aretaeus of Cappadocia and of Vesalius. Then there was the costly venture of Vaillant's *Botanicon*, already mentioned. But to my mind Boerhaave's greatest service of this nature to science was his publication of the work of Jan Swammerdam. Swammerdam of Amsterdam was possibly the greatest of all micro-dissectors until the present century, and he spent much of his life in performing wonderful dissections of insects and other lower animals. He had made beautiful drawings of these dissections and had written in Dutch the text of a book. After his death these manuscripts had a chequered history until they were purchased at great expense by Boerhaave, who decided to publish them. There were great difficulties, but the book was finally published in two folio volumes, edited by Boerhaave and his former pupil Hicronymus David Gaub, with the title *Bybel der Natuure* (*Bible of Nature*). Gaub translated Swammerdam's text into Latin. The second volume of this work reached Boerhaave on his death-bed. It is quite probable that, but for Boerhaave's action, Swammerdam's magnificent biological work might never have been given to the world of science.

Boerhaave's Influence

As this subject is touched on in most of the books, it will be treated very briefly here. During the 29 years of Boerhaave's professorship 178 students graduated under him at Leiden. But this figure gives no indication of the number of students who were trained by him, since, according to the custom of the time, many students who studied at Leiden graduated at other universities. Actually, Boerhaave had very large classes, as is known from the class rolls of some of his later classes, which are still preserved. In his later years about 100 students attended each of his clinical courses. During the whole of his teaching career he had an international audience. Of the 178 students who graduated under him, 76 were Dutch, 48 came from German-speaking countries, and 43 were British. Of the students who attended his classes a considerable proportion nearly always came from the British Isles.

It is well known that three famous universities were directly influenced by Boerhaave's pupils; but it does not seem to be recognized—at least I do not remember having seen it so stated in print—that the *first* to receive the true impact of Boerhaave was Edinburgh. The story of the foundation of the Medical Faculty of Edinburgh has often been told, but it is not sufficiently realized that, of the nine men who at one stage or another had associations with the foundation of the faculty, all without exception had studied at Leiden under Boerhaave. Of these nine, five became the first professors. Alexander Monro *primus* was appointed to the new chair of anatomy in 1720. The faculty was formed by the appointment of the other four—John Rutherford, Andrew St.Clair, Andrew Plummer, and John Innes—to new chairs in 1726. Charles Alston, who succeeded George Preston in the chair of botany in 1729, had also studied under Boerhaave. Surely this is a unique case of a great teacher having seen a whole faculty founded by his own students during his lifetime.

It is well known that Boerhaave had very few students from America and that none of them afterwards made their mark at home. But after his death students came from America to Edinburgh to study medicine, and some of them became the pioneers of American medical education.

The second European university to be influenced by Boerhaave was Göttingen, to which on its foundation in 1736 the 28-year-old Albrecht von Haller was called as professor of anatomy, surgery, and botany. Haller's very important works testify to his debt to Boerhaave as a teacher and an inspirer of research.

The third university to be influenced by Boerhaave's School was Vienna. After Boerhaave's death the Medical Faculty at Vienna was at a low ebb, and Van Swieten, Boerhaave's favourite pupil who had long been a physician at Leiden, was called to Vienna in 1745 as professor of medicine. Within a few years he had become head of the faculty, had revolutionized it, had had a teaching hospital founded, and had procured as its head his slightly younger contemporary, Anton De Haen, who had also been a pupil of Boerhaave.

At all these universities the teaching was strictly on Boerhaave's lines, and it was his textbooks that were used.

It is not necessary to discuss here the work of Boerhaave's pupils in other countries. Enough has surely been said to show that there is at least some truth in Haller's description of Boerhaave as *communis Europae praeceptor*—and by that phrase he meant a teacher not only of facts and theories, but also of the spirit and methods of research.

Epilogue

When Boerhaave died his funeral oration was delivered by his friend Professor Albert Schultens, who published it in 1739. In the same year Samuel Johnson, then a young journalist, contributed a Life of Boerhaave to the *Gentleman's Magazine*. This short biography was drawn entirely from Schultens's Latin oration and from a perusal of a few of Boerhaave's academic orations. Unfortunately it contains factual errors that are not in Schultens's work, and from the scientific aspect it added nothing to our knowledge of Boerhaave. But it was later republished in Johnson's Collected Works, and thus it has become the readily available English source for information on Boerhaave. It is still used and quoted, errors included. During the next twelve years five brief accounts of Boerhaave's life and work were published, all but one by his former pupils. After that, nothing. Now, after the lapse of over 200 years, Boerhaave has found in Professor Lindeboom a biographer who has read all the extant contemporary evidence, in manuscript and in print, who has studied Boerhaave's works with knowledge and understanding, and has drawn his own long-considered conclusions. No departed scholar or scientist could wish for more.

References

[1] F. W. Gibbs, *Ambix*, 1958, **6**, 117–135.

[2] See G. A. Lindeboom, *Herman Boerhaave*, London, 1968, pp. 328–52. See also J. Read, *Humour and Humanism in Chemistry*, London, 1947, pp. 132–55. A more closely written account is given in J. R. Partington, *A History of Chemistry*, London, vol. 2, 1961, pp. 746–58.

[3] In the second volume of his *History* (1961, p. 758) J. R. Partington stated that what Boerhaave prepared might have been microcosmic salt; but in his third volume (1962, p. 78) he seems to have concluded that Boerhaave had indeed discovered urea.

[4] H. J. Backer, *Ned. T. Geneesk.*, 1943, lxxxvii, pt. ii, 1274–78. Backer was able to accelerate Boerhaave's process without altering his fundamental method. Backer, like Partington, who does not seem to have been acquainted with Backer's paper, thought that Boerhaave's urea *may* have been in an impure form—namely, the hydrate of urea and sodium chloride. He further thought that this impure form may also have been the substance later independently discovered by Rouelle and by Fourcroy and Vauquelin.

[5] H. Boerhaave, *Atrocis, nec descripti prius, morbi historia*, Leiden, 1724. In 1964 G. A. Lindeboom published a fascimile of the first edition and of the first French translation.

[6] T. C. Allbutt, *Brit. med. J.*, 1900, **2**, 1848–52.

[7] G. A. Lindeboom, *Mededelingen van de Konink. Vlaamse Acad. v. Wetenschappen, Letteren en Schone Kunsten van Belgie*, Kl. d. Wetensch., 1961, xxiii, No. 2, pp. 30–32.

[8] It is noteworthy that Osler possessed only the original Latin edition of the *Elementa chemiae* (*Bibliotheca Osleriana*, p. 112, No. 1094, Oxford, 1929). He had the English translation of the spurious Latin edition of 1724, but not Shaw's 1741 translation of the genuine *Elementa*. In his unpublished paper he did indeed quote a few sentences from this work by Shaw, but they were from an appendix written by Shaw himself and not translated by him from Boerhaave's text; and further, they referred to Boyle and not to Boerhaave. It is also noteworthy that Osler, in his posthumous *Evolution of Modern Medicine* (1921), which was based on lectures delivered in 1913, has not a word about Boerhaave's chemical investigations.

[9] T. C. Allbutt, *Greek Medicine in Rome*, London, 1921, pp. 529–40.

[10] The works to which I refer in this paragraph are as follows: (1) C. A. Wunderlich, *Geschichte der Medicin, Stuttgart*, 1859, pp. 166–71. (2) C. Daremberg *Histoire des Sciences médicales*, Paris, 1870, vol. 2, pp. 889–905. (3) H. Haeser, *Lehrbuch der Geschichte der Medicin, und der epidemischen Krankheiten*, vols. 2, and 3, 1881–82, in many places, but especially vol. 2, pp. 496–508. (4) J. H. Baas, *Grundriss der Geschichte der Medicin*, Stuttgart, 1876, pp. 472–6; and the revised edition translated by H. E. Handerson as *Outlines of the History of Medicine*, New York, 1889, especially pp. 603–07. (5) E. T. Withington, *Medical History from the Earliest Times*, London, 1894, pp. 324–27. (6) *T. Puschmann's Handbuch der Geschichte der Medizin*, edited by M. Neuburger and J. Pagel, Jena, vol. ii (1903) and vol. iii (1905)—many references in vol. ii, but especially pp. 74ff., and pp. 457–72, and also in vol. iii. (7) J. L. Pagel, *Einführung in die Geschichte der Medizin*, 2nd ed., revised by Karl Sudhoff, Berlin, 1915, pp. 302–4. (In the combined third and fourth editions Sudhoff did mention the *Elementa chemiae* on p. 299, but only in a bibliographical list and without comment.) (8) F. H. Garrison, *Introduction to the History of Medicine*, 2nd ed., Philadelphia, 1917, pp. 309–11. Garrison's account contains a number of factual errors. He admits that the *Elementa* was the best book on chemistry during the eighteenth century, but he appears to have found nothing of interest in it except that Boerhaave introduced the idea of chemical affinity and invented an improved method of making vinegar. He does not link up Boerhaave's chemical with his clinical work. Garrison quotes a phrase from Allbutt's paper, and it would seem that in this matter he was much influenced by Allbutt. In his fourth edition (1929, pp. 315–17) Garrison expands this section on Boerhaave slightly, but without change of attitude. (9) Sir Michael Foster, in his *Lectures on the History of Physiology*, Cambridge, 1901, pp. 200–4), perhaps approaches nearest to the actual significance of Boerhaave's chemical physiology, though he deals only with the aspect of Boerhaave's work relating to digestion.

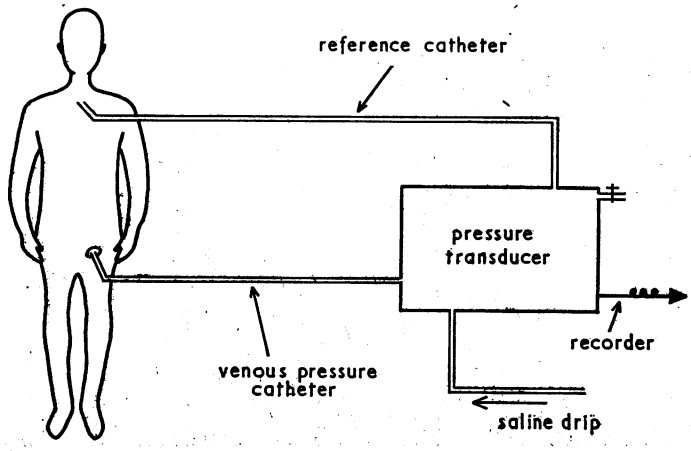
NEW APPLIANCES

Self-levelling Venous Pressure Transducer

Dr. J. P. BLACKBURN, Department of Clinical Measurement, Westminster Hospital, London S.W.1, writes: Venous pressure may be measured with a saline-filled manometer, but where more detailed information is required or a continuous record is needed an electromanometer is commonly used.

Levelling any pressure-measuring device is important, particularly for venous pressure measurements, and a number of methods have been described (Sykes, 1963; Bethune *et al.*, 1966). Levelling must be repeated every time the patient changes position.

When a differential electromanometer* is used for the measurement of pressure automatic compensation for changes in the position of the patient can be arranged as shown in the diagram. The reference limb is an open-ended water-filled tube† which is attached to the patient's skin at the sternal angle or other suitable reference point. The other side of the transducer diaphragm is connected to the intravenous catheter in the usual way. Changes in the position of the patient affect both the venous and the reference catheter equally, so the measured pressure is always related to the reference catheter and the transducer need not be moved.



Arrangement for differential pressure measurement.

References

Bethune, D. W., Gillett, G. B., Watson, A. C., and Crichton, T. C. (1966). *Lancet*, **2**, 684.

Sykes, M. K. (1963). *Ann. roy. Coll. Surg. Engl.*, **33**, 185.

* Sanborn Physiological Pressure Transducer Model 268B.

† Portex 6-ft. (183-cm.) Manometer Connector Tubing B208.