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The Resuscitation Greats

John Snow and resuscitation

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1. Introduction

John Snow's work on resuscitation is less well known than his contributions to the scientific foundations of anaesthesia [1]. However, together with his understanding of the physiopathology of respiration, it was not the least of the reasons for his fundamental contributions to anaesthesia. His initial work on resuscitation with asphyxiated stillborn infants, was published in 1841 [2], but, as his anaesthesia textbook of 1858 shows, he maintained an interest in resuscitation for the rest of his career [3].

2. Snow's career

John Snow (Fig. 1) was born on March 15, 1813 in the ancient English city of York [4]. His early medical training included a short period at the medical school in Newcastle, an apprenticeship to a doctor in the same city, and assistantships to two physicians back in Yorkshire. In 1836, deciding that he should take further training, he set out, on foot, for London, where he enrolled as a student in the Hunterian School of Medicine and then at Westminster Hospital. To break into London's medical hierarchy, he climbed the rungs of the academic medical ladder with characteristic thoroughness. In 1838 he passed the examinations for membership in the Royal College of Surgeons and for the licentiateship of the Society of Apothecaries; in 1843 he obtained the diploma (MB, BS) of London University; in the following year he was awarded the MD of London University; and to cap it all, in 1850 he became a licentiate of the Royal College of Physicians of London, which was as far as the current regulations would permit this

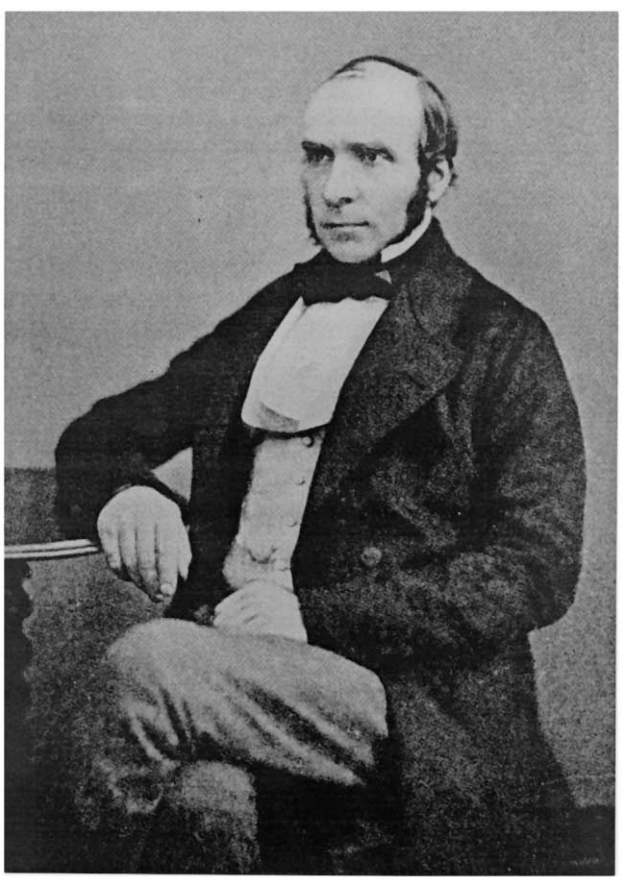

Fig. 1.

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Yorkshire lad to go. By then, however, he was well known, both in London and other parts of Great Britain. A regular participant in the meetings of the Westminster Medical Society (which merged with the Medical Society of London in 1850)[5], beginning in 1847 he published classic texts in both anaesthesia and the epidemiology of cholera that eventually brought him renown. On the Inhalation of the Vapour of Ether in Surgical Operations… appeared in 1847 [6]; a series of papers 'On Narcotism by the Inhalation of Vapours' was launched in 1848 [7]; the first edition of On the Mode of Communication of Cholera followed in 1848 [8]; and the better known second edition of this monograph came out in 1854 [9]. Success bred further success: in 1853 and 1857 he anaesthetised Queen Victoria in labour, and in 1854 he was elected president of the Medical Society of London and of the Physiological Society. Just before he died on June 16, 1858, he completed his great text On Chloroform and Other Anaesthetics… [3].

ON

ASPHYXIA, AND ON THE RESUSCITATION OF STILL-BORN CHILDREN.

By John Snow, M.R.C.S.*

(For the London Medical Gazette.)

Respiration, in a limited sense, signifies the mutual change which takes place between the oxygen of the air and the blood; and this is not strictly a vital process, but only an operation of organic chemistry, since it continues after death as well as before, when the mechanical advantages for access of air remain the same. The celebrated Spallanzani, in his work on Respiration, has shown that snails and other animals, which respire chiefly by the surface of the body, continue after death to absorb to some extent the

Read at the Westminster Medical Society on October 16, 1841.

Fig. 2.

3. Resuscitation of the stillborn

On October 16, 1841, when Snow read his paper on asphyxia and the resuscitation of stillborn children before the Westminster Medical Society he was on the threshold of a remarkable career (Fig. 2) [2]. He began his paper by discussing respiratory physiology and the effects of asphyxia, making the basic premise that "respiration seems essential to the life of the whole animal kingdom and when it is arrested from any cause the state called asphyxia is induced". Snow then addressed two questions that were moot at that time: first, whether 'insensibility' resulted from circulation of blood that was venous or from 'stoppage' of the circulation; and second, whether the carbon dioxide resulting from respiration was formed in the lungs by 'direct union' of oxygen in the air and carbon in the blood or whether oxygen was absorbed in the blood united with the carbon in the capillary circulation. He answered the first question by concluding that "blood which has totally lost its arterial properties, is unable to maintain sensibility or even vitality"; the second, by stating that carbon dioxide was indeed formed in the tissues. Snow's account of the context of the physiological knowledge of his time remains of interest today for, as Calverley noted, "it orients the reader to the knowledge of respiratory physiology and resuscitation that would have been available to a clinician at the time of the discovery of anaesthesia" [10].

Snow then turned to practical considerations. In reviewing the influence of temperature on the effects of asphyxia, he observed that lower temperatures enhanced survival, but also noted that the Royal Humane Society advocated warmth under these circumstances. Snow's recommendation was that heat should be avoided until respiration had been reestablished, when it would be 'a useful auxiliary to restore sensibility and renovate the patient'.

Snow's main purpose in presenting his paper of 1841, however, was to describe a device that would serve as 'a useful auxiliary' in resuscitating the asphyxiated stillborn (Fig. 2). His own experience in general practice had shown him that a 'very considerable' number of the newborn die at birth, and he reminded his audience that the literature indicated that one-twentieth of infants delivered were stillborn, many of whom were asphyxiated. Measures such as exposure of the baby's skin to cool air or cold water and immersion of the infant in warm water were sometimes beneficial, but more important, Snow believed, was artificial respiration. In these babies, he wrote, 'the great object… is to establish respiration; and

if the patient cannot be roused to perform natural breathing, artificial respiration must be had recourse to as quickly as possible'. He dismissed both the standard recommendations of 'breathing into the lungs of the child', which he felt might injure or suffocate the infant, and using the bellows which might damage 'the texture of the lungs by over distension', and more to Snow's point, was marred by 'the difficulty of expelling the air from the lungs after it has been injected….' Snow had a better solution: a modification of a device that was "superior" to the bellows and one that had, in fact, been demonstrated before the Westminster Medical Society three years earlier by a Mr Read of Regent Circus, and Dr James Johnston. Their instrument was designed for use in adults, and its possible use for stillborn infants then seemed to Snow to have 'insurmountable difficulties'. Read, however, made some improvements, and showed Snow what he had done. Snow thereupon suggested that 'he should make a little instrument on exactly the same plan, adapted to the size of new-born children'. It was this new instrument that Snow described on that October evening in 1841:

> It consists of two syringes, one of which, by a tube adapted to the mouth, and closing it withdraws air from the lungs, and the other syringe returns the same quantity of fresh air through a tube fitted to the nostrils. The two pistons are held in the same hand and lifted up and pressed down together, the cylinders being fixed side by side and each having two valves. When the pistons are raised, one cylinder becomes filled with air from the lungs, and the other with fresh air from the atmosphere, which can be warmed on its way by passing through a tube and metal coil placed in hot water. When the pistons are depressed, the latter cylinder is emptied into the lungs, and the air in the former is ejected into the atmosphere. In this way a constant current of air to and from the lungs is maintained, as in maternal respiration.

Snow emphasized two other points. One was to clear the airway before initiating artificial respiration. He recommended that 'the exhausting syringe be used first to remove any mucus there may be about the fauces; then, since the lungs are empty, a little air may be injected with the other syringe, before beginning with the pistons raised to work the two syringes together'. Snow, observing that 'the danger of asphyxia to the child is frequently foreseen', implied that physicians should have appropriate equipment ready in cases of abnormal labour and of haemorrhage. He also recommended that supplemental oxygen be used. Oxygen could 'be generated, in great purity in a few minutes, from chlorate of potash by means of a spirit-lamp and a small retort…, after which it could be mixed with air 'in one of the bags belonging to the instrument'. If all other means failed Snow supported the use of electricity, in 'the form of galvanism…', saying there was 'no harm in administering slight shocks after these other means have failed'. He claimed the main intention was to stimulate respiratory movements as he believed 'that oxygenating the blood in the lungs is the most efficient means to restore the action of the heart….'

There is no evidence that Snow used the double-syringe apparatus on any infants. His paper was evidently presented as the theoretical basis for neonatal resuscitation. Even so, Snow's place in the annals of neonatal resuscitation is secure. As Calverley observed, Snow was 'the first to recommend consideration of both the use of supplemental oxygen and the aspiration of material from the mouth and upper airway before initiating ventilation-the two cardinal principles of modern practice' [10].

4. Resuscitation in anaesthesia

In his paper on resuscitation of the stillborn, Snow described an experiment he performed on a guinea pig that he had drowned. After an hour he applied artificial respiration via the divided trachea, and observed that 'rhythmical contractions of the heart continued for three-quarters of an hour'. He was therefore familiar with artificial respiration as a means of resuscitation in anaesthesia, both in his research and in the advice he gave clinicians in administering anaesthesia. For example, in an experiment to determine the effects of chloroform in a rabbit he observed that with 10% chloroform the right heart became distended with blood and that "the action of the heart was quite reestablished by the artificial respiration"; he also

noticed that the lungs "became paler, as the artificial respiration was continued..." [11] (Fig. 3). And clinically, as he wrote in 1855, 'I still consider, as I have all along, that artificial respiration, promptly and efficiently applied, is the best means of affording the patient a chance of recovery from an overdose of chloroform' adding that he knew 'from experiments that it will not answer if the heart is completely paralysed' [12].

Snow noted the means of resuscitation, including artificial respiration, that had been used in the first 50 cases of cardiac arrest reported in patients who had received chloroform [3]. The techniques of resuscitation included use of the 'tracheal tube', administration of oxygen, mouth-to-mouth or mouth-to-nostril ventilation, compression of the ribs and abdomen, and introduction of galvanic current. Of the techniques of artificial respiration, Snow favoured the Marshall Hall method, which consisted of 'placing the patient on the face and making pressure on the back; removing the pressure, and turning the patient on his side and a little beyond...' and repeating these manoeuvres 'in about the time of natural respiration' [13].

ON

CHLOROFORM

AND

OTHER ANÆSTHETICS:

THEIR

ACTION AND ADMINISTRATION.

BY

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Fig. 3.

5. Comment

Snow's profound knowledge of resuscitation was based on his knowledge of the physiopathology of respiration and of the pharmacological effects of chloroform and other anaesthetic agents, as well as his wide knowledge of medicine. Interest in resuscitation, especially of the drowned, had grown following the founding of societies in the latter part of the 18th century to foster this interest in Holland and in England [14]. Among those with an interest in resuscitation was John Hunter, who invented a double chambered bellows-one chamber to fill the lungs and the other to empty them [15]. Snow's work on resuscitation was therefore a continuation of the studies in this field. It added to the knowledge on resuscitation, although Snow approached it from a different perspective. His work also foreshadowed other advances, particularly in neonatal resuscitation, with the studies of other anaesthetists such as Virginia Apgar [16].

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