JOHN SNOW AND PARACENTESIS OF THE THORAX

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Early paper by John Snow

Probably there are not many among us today who appreciate that pleural effusion, or hydrothorax, unilateral or bilateral, was quite a common condition even fifty years ago, and much commoner still in John Snow's time. It was the subject of one of his early communications. On Saturday 7 December 1839, when he had been qualified and in general practice in Soho for only one year, he read a paper at a meeting of the Westminster Medical Society. The title was '*The Anasarca which follows Scarlatina.*'[1] Anasarca (from Greek, ana=up or through, sarx, sarcos=flesh), or dropsy, was the old name for oedema, and in the extreme form it extended from the feet upwards through the abdomen and thorax to the face and eyelids. Patients who died were found to have pleural and pericardial effusions, and ascites. Treatment in Snow's time was both local, by puncturing the skin to allow fluid to drain out, and more elegantly, later, by the insertion of Southey's tubes; and systemic, by emetics, purgatives and diuretics. None of the medicaments was pleasant. Purgatives included jalap and calomel, and among the diuretics were juniper, horseradish, mustard, and oil of turpentine. Digitalis is often mentioned as being a powerful remedy, especially where the pulse is feeble or intermittent.[2]

In his talk, Snow reported on a recent epidemic of scarlet fever in the metropolis, where the subsequent anasarca, associated with kidney disease, had been unusually frequent and in some cases fatal. He mentioned that the attribution of oedema to renal disease, and the first demonstration of albumen in the urine of dropsical patients, had been fairly recent Dr Bright had discovered its relationship with certain diseases of the kidney, and had found also that this condition of the glomeruli might be occasioned by scarlet fever.[3]

Post-Scarlatina Dropsy

Snow went on to describe twelve cases of post-scarlatinal dropsy, five of which had been fatal. The first was a girl of twelve, who died suddenly after severe scarlet fever. Post mortem there was generalised oedema, together with ascites, and extensive pleural and pericardial effusions. Snow demonstrated this child's much enlarged kidneys at the meeting, and also showed the much enlarged and disorganised Malpighian bodies under the microscope. Her brother, aged nine, also had severe oedema and ascites, but recovered after a regime of purgation and venesection, though with obviously severely damaged kidneys. Post mortems were done on two of the other four fatal cases, and pericardial effusions were found in both. In one of those who recovered, Snow described extensive dullness to percussion in the cardiac area, and in the other great difficulty in breathing. In this last one, he said that 'the increased action of the heart continued, and a loud bellows-sound became established with the first sound'. At the time of the meeting the child was still under treatment, but his future was obviously dim.

The remainder of Snow's paper is devoted to a discussion of the reason for the association in some cases of scarlatina but not others, of kidney disease and severe anasarca. We need to remember that this was before Pasteur, when scarlet fever was still a mystery illness. During

the subsequent discussion, a Dr Addison said rather cattily that he thought that Bright was wrong to make the sweeping assumption that the disease of the kidneys was the *fons et origo* of the dropsy. (It seems almost certain that this was William Addison FRS of Wimpole Street, not Thomas, the Guy's physician who described the eponymous disease of the suprarenal capsules some years later; there were only two Addisons listed in the Medical Directory of this period). He was sure that with further experience it would be found that Bright was confusing an effect with a cause. Another speaker described a child of four who had died of anasarca and pericarditis after scarlatina.

Seriousness of Scarlet Fever

Again, only the oldest of us will remember how common, and how dreaded, scarlet fever used to be. Before the era of sulphonamides and antibiotics it was a killer, both in the acute phase and as a result of the sequelae of rheumatic heart disease and glomerulonephritis. The epidemic that Snow reported, with the deaths of children, obviously remained in his mind, because two years later, on Saturday 18 December 1841, (incorrectly dated 19 in the *Lancet*), he read a paper at the Westminster Medical Society on Paracentesis of the Thorax.[4] An account of this talk was published in both the *Lancet* and the *London Medical Gazette*. The versions differ in some details. The one in the *Lancet* was taken down at the meeting by its reporter, and missed several significant points, but it had the important feature that it also reported the ensuing discussion. The paper in the *Gazette* was prepared and submitted by Snow himself, as was his custom. An editorial footnote to one of his earlier communications to the *Lancet* had indicated that they were not welcome, whereas he was obviously on good terms with the editor of the *Gazette*.

Snow as teacher

We are accustomed to regarding John Snow as a great teacher of the art of anaesthetics; but it is noteworthy that even in his early years he was a teacher. His papers generally began with an exposition of the basic science involved. In one case this was physics, but usually (as here) it was physiology, and he obviously thought this necessary because of the great disparity between the beliefs of the senior practitioners and all the recent advances that were being taught in the medical schools. The need for this scientific introduction is seen clearly in some of the contributions to the discussion that followed the main speaker.

Snow began by explaining that: 'In the normal condition there is no vacant space in the thorax'. The pleural cavities are empty, the pulmonary and costal surfaces 'glide gently over each other during respiration. Whenever any fluid, whether a liquid or a gas, accumulates within the pleura, it is desirable that we should get rid of it'. He continued that tapping the thorax was, however, in practice restricted to cases where the liquid was known or presumed to be pus, or where the volume of liquid or air in the pleural sac was so great that not only was the affected lung useless, but the mediastinum was pushed across to such an extent that the function of the other lung was so impaired as to endanger life.

Dangers of paracentesis

But what Snow called the ordinary methods of performing paracentesis of the chest, whether by trocar or bistoury, carried their own evils. The lungs would only follow the movements of the chest as long as the atmospheric pressure inside them, and on the chest wall, was equal.

No sooner was an artificial opening made into the pleura, than the atmospheric pressure became equal on the inner and outer surfaces of the lung on that side, and it would collapse in accordance with its own elasticity and remain unaffected by the movements of the ribs and the diaphragm. Thus it followed that at the conclusion of paracentesis performed in the ordinary way, the lung would remain collapsed if the space previously occupied by liquid was left full of air.[5] In fact, with the stethoscope applied to the chest, air could be heard bubbling in as the liquid was removed. The great evil that arose from the admission of air was its mechanical resistance to the expansion of the lung. The lung on that side could only expand in proportion to the absorption of the air, and this took a number of days, during which the patient suffered from limited respiration, and ran the risk that the lung might be bound down by the consolidation of coagulable effusion, and never expand again.

Leave the pleura empty

So it would be a great advantage to leave the pleura empty, with the lung expanding and filling the chest, and even more so when both cavities were affected. In such cases, to make an opening into each pleura and allow both lungs to collapse, would be to cause instant death by asphyxia. In fact, when dyspnoea was caused by liquid in both pleurae, the patient could not dispense with one of his embarrassed lungs and attempt to live on the functioning part of the remaining one. Accordingly, paracentesis was not performed on such patients, although fluid which occupied both sides of the chest would soon prove fatal if not relieved. Such a condition, arising from disease of the heart or the kidneys, was a frequent occurrence, and although sometimes a symptom of approaching dissolution, at others it cut the patient off much sooner than the original affection would have done. For example, the dropsy arising from granular degeneration of the kidneys could occur at any stage of the disease, and in the form of bilateral hydrothorax could be fatal if not removed, even when the disease of the kidneys was at an early stage. In the case of renal dropsy following scarlet fever that he reported two years previously, a child was cut off by hydrothorax, though it was not worse in other respects than some who recovered.

Snow could not see why tapping might not be performed in these cases of bilateral effusion, where it might be life-saving, as long as the method did not allow communication between the pleural cavity and the outside air. A method had been proposed recently by Dr Davidson of Glasgow, which was to place a cupping glass over the cannula to prevent air from entering. But air had rushed in when the cupping glass was removed, and the splashing of fluid could be heard in the chest, a positive Hippocratic sign, three days after the operation.

Snow's Trochar and Cannula

So the chief object of his paper was to bring before the Society an instrument by which fluid could be withdrawn from the chest without making any direct communication between that cavity and the outside air. It consisted of a trochar, and a cannula with a stopcock. The trochar passed through the stopcock in the open position, and made an accurate fit along the whole length of the cannula. When the trochar was withdrawn, it would still make an airtight fit when it was clear of the stopcock, allowing it to be closed before the trochar was completely removed, so that no communication with the atmosphere could take place. A mark on the trocar showed when it was clear of the stopcock, which could then be closed before the trochar was completely withdrawn. Unfortunately, although an illustration of the apparatus was shown at the meeting, it was not reproduced in the journals. In a footnote, the

editor of the *London Medical Gazette* wrote that although a drawing had been supplied, the description had been so distinct that it had not been thought necessary to have an engraving made. However it is likely that in its essentials the instrument resembled the following illustration.

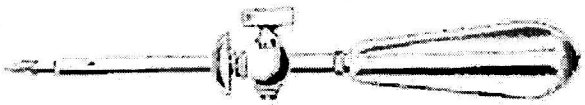

Figure 1. Snow's cannula reconstructed

The other part of the instrument was a double-action syringe with two valves, similar to a stomach pump. This must have been a version of the Read pump, which was also the basis of Snow's neonatal resuscitator, described by him two months earlier. In a footnote to his paper in the Gazette, Snow said that since the meeting the trochar and cannula had, in fact, been made for him by Mr Read of Regent (now Oxford) Circus.[6,7]

Snow suggested that before introducing the instrument the skin should be drawn across, so that when the cannula was removed the skin would slide back and block any direct communication between the deeper wound and the outside. If this was an original suggestion it is a worthy example of Snow's ingenuity, and it has, of course, remained standard practice.

Ensuing discussion

Why Snow thought it necessary to introduce his talk with an account of the mechanics of respiration is made evident by the ensuing discussion: 'Dr. Addison asked what objection there was to the introduction of air into the pleura? He admitted that the instrument was a very ingenious invention to prevent that occurrence, but he had never seen any evil result from it'. The pump would not expand a lung bound down by organised lymph, and a lung not bound down would expand and contract with the motion of the chest although air was contained in the pleura. 'He saw no objection to the entrance of air, for the hydrothorax did not cause inconvenience by preventing the expansion of the lungs, but by pressing on the mediastinum, and thus interfering with the circulation of the blood, for they knew that respiration might be greatly limited, and that one lung might be altogether dispensed with without inconvenience.'

Dr Frederick Bird said that the entrance of air into the pleura during paracentesis did no harm, and he mentioned two or three cases in which there was pneumothorax immediately after the operation, but the air was absorbed after a few hours. He did not consider the instrument to be an original invention. It appeared to be a modification of a recent German idea, where an empty bag was drawn over the trochar and cannula, and fastened to the chest by adhesive plaster. The trochar, when withdrawn, was allowed to fall into the bag, into which the liquid also flowed.

The President, Dr Golding Bird, said that air admitted during paracentesis was a highly elastic and compressible fluid, and would not offer as much resistance to the expansion of the lung as the fluid that was being removed. Golding Bird was assistant physician to Guy's Hospital, and Professor of Materia Medica. He lived for some years at 48 Russell Square, now the home of the Royal College of Anaesthetists, and died at the age of 41, from

rheumatic heart disease. He and Snow appear to have collaborated on one or two research projects in their earlier years, and in his *Case Books* Snow records two occasions when Bird was present during operations for which he (Snow) anaesthetised.

Replying to the discussion, Snow said that the greatest objection he had to the admission of air was the mechanical resistance it would afford to the expansion of the lung. When left to itself, the natural elasticity of the lung would leave a considerable space between itself and the ribs, to be occupied by air. He was still of the opinion that when dyspnoea was great from effusions pretty equal on both sides, the patient could not spare the use of one lung for a moment to allow of tapping in the ordinary way, without a risk of losing his life. When hydrothorax caused difficulty of breathing, it could only be by preventing the expansion of the lungs; it could never interfere with the circulation in any other way. The pressure on the large vessels would always be the same as in health, however large the effusion.

He was pleased to hear of the German invention, because it showed that others objected to the admission of air; but although it excluded air, it would be impossible to extract all the liquid, especially in empyema.

In conclusion, Dr Addison remarked that although he had an invention of his own to prevent the admission of air, he would be happy to try Mr Snow's instrument when he had a case requiring the operation.

So here we see John Snow describing a completely new instrument, based on a sound understanding of the physiology involved, designed to allow a hitherto impossible life-saving procedure, the drainage of bilateral pleural effusions, to be performed safely. It is not easy to find examples where advances in physiology influenced treatment during this period, and previous writers about Snow do not appear to have appreciated the innovatory nature both of this apparatus and of the thought behind it. It was the precursor of all trochars and cannulas and all exploring and spinal needles fitted with a stopcock. There are many to be found in instrument makers' catalogues, and if there were any justice, all should have been called modifications of Snow's cannula. How far he was ahead of his times in this, as in so much else, can be seen from the following.

Treatment of empyema

Until 1920 the routine treatment for empyema was still rib resection and open drainage, and many died as a result. Matters came to a head during the 1918-1919 influenza epidemic, during which a large number suffered from the complication of streptococcal empyema. The death rate among American servicemen as a result of open drainage was so appalling, (70% in some centres) that an Empyema Commission was set up to find the cause. Its report pointed out the fatal error of the neglect of the physiology of the open chest wound.[8] As a result, closed drainage, either intermittent or with the water seal that we are familiar with, became standard. So here, as in other things, Snow had been many decades ahead of his time.

Conclusion

What will appear strange to us today is that it seems to have been perfectly acceptable to his contemporaries that he should give a talk, and provoke a discussion, about an instrument that had not yet even been made, let alone used.

References

1. Snow, J. The anasarca which follows scarlatina. *Lancet* 1839-40; **i**:441-444.
2. Hooper, R. *Medical Dictionary. London,* Longman, 4th edition, 1820, 49-51.
3. Bright, R. *Reports of Medical Cases.* London, Longmans, 2 vols. 1827-1831; and Cases and observations, illustrative of renal disease accompanied by the secretion of albuminous urine, *Guy's Hospital Reports* 1836; **1**:338-400.
4. Snow, J. Paracentesis of the thorax. *Lancet* 1841; **ii**:483-486; also *London Medical Gazette* 1841-2; **29**:705-707.
5. Carson, J. *Essays, Physiological and Practical.* Liverpool, Wright, 1822. Carson drew attention to this property of the lung, and proposed the induction of artificial pneumothorax for the treatment of pulmonary tuberculosis.
6. Snow, J. On asphyxia, and the resuscitation of still-born children. *London Medical Gazette* 1841-2; **29**:222-227.
7. Owen, B. A man named Read. *Proceedings of the History of Anaesthesia Society* 1995; **17**:86-92.
8. Coope, R . *Diseases of the Chest.* Edinburgh, Livingstone, 1944, 376-377.