instructions, however, must not be too detailed as to prevent them from being read at the time of the emergency or to inhibit personal initiative. Other important members of the hospital staff also have vital tasks to perform, but it is equally important that their instructions should be explicit and detailed and that individual initiative, so far as the organizational side is concerned, should be discouraged. Other members of the staff—medical, nursing, and ancillary—must know who to report to in order to receive verbal or written instructions.

Of the many lessons we learnt, three stand out. Firstly, communications must be secure, both inside the hospital, with direct lines connecting vital centres, and outside, with a direct radio link between the major accident officer and the site senior medical officer. The hospital must also have ex-directory lines, so that outgoing calls can still be made if the switchboard is swamped with incoming calls. Secondly, written instructions in the form of action cards must be provided in key positions. We have installed major accident boxes containing copies of the major accident procedure, action cards, and other items of equipment in the control centre and accident and emergency department and at the main reception desk. Thirdly, hospital personnel must be made constantly aware of their duties in a major accident, by means of permanent display charts and by regular departmental discussions with the major accident officer.

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John Dawson (1734-1820)*

C. C. BOOTH,† M.D., F.R.C.P.

Britain has been a settled community for more than a thousand years. But in the seventeenth and eighteenth centuries there were still isolated areas in England that demanded from their sons qualities of sturdy independence similar to those that in later years pushed the American frontier westwards and developed the Australian Outback. One such area in this country was the Yorkshire dales, a group of rugged but beautiful glacial valleys cut in the Pennine limestone in the north-west corner of Yorkshire.

Between 1697 and 1780 these isolated valleys produced a remarkably talented group of doctors, all of whom were characterized by their originality, and many of whom are remembered today for their contributions to the advancement of medical knowledge. They included John Fothergill of Ravdale (Hingston Fox, 1919; Corner and Singer, 1954; Booth, 1957); William Hillary of Wensleydale, the first man to describe tropical sprue clearly and George Washington's doctor in Barbados (Booth, 1963); John Haygarth, who pioneered isolation techniques in the prevention and treatment of infectious fevers (Weaver, 1930); Anthony Askew, one of the owners of John Radcliffe's famous gold-headed cane; Anthony Fothergill of Sedbergh; George Birkbeck, after whom Birkbeck College is named; and Robert Willan, the famous dermatologist (Booth, 1968). To these must be added John Coakley Lettsom, who served his apprenticeship to a Quaker apothecary, Abraham Suttcliffe, at Settle in Ribblesdale (Johnston Abraham, 1933). As with pioneers in other continents, many of these men were radicals and nonconformists, a reflection of the individualism of those rugged but lovely valleys. All but one lived for the early and formative part of their years in these Yorkshire dales, and most were educated at the famous grammar school at Sedbergh. But none stayed in the land of their birth, their ambitions leading their medical careers to cities such as Ripon, Bath, Northampton, Darlington, Edinburgh, London, and Leiden, and in two instances to places as far afield as Pennsylvania and the West Indies.

This paper describes another, humbler son of one of these Yorkshire valleys, a man who had no formal education and who was virtually self-taught. Yet he became a doctor, knew and taught some of his distinguished compatriots; but he worked for most of his long life as a country practitioner in the valley of his birth. He was also a remarkable mathematical genius who developed a national reputation, and this brought to him as pupils at his modest home at Sedbergh 12 men who were to become senior wranglers at the University of Cambridge (Clark and Hughes, 1890).

Early Years

John Dawson was born at Raygill Farm in Garsdale in 1734. His father, William Dawson, was a "statesman" earning at that time not more than £10 or £12 in a year. Dawson's birthplace is little altered by the passage of nearly 250 years, and the valley of Garsdale, never penetrated by railway or bus route, scarcely visited by tourists even today, is serene and untroubled by the passing centuries. Inside the house the present occupants preserve a carved cupboard door on which can be read the initials J.D. 1667, an earlier member of the Dawson family.

Until he was over 20 years of age John Dawson worked as a shepherd on the hills. High on the moor above his home there is a stone called Dawson's Rock where, according to local tradition, young Dawson sat and worked out a system of conic sections entirely for himself. His family's limited resources made formal education unavailable to him, and according to one account Dawson educated himself by begging or borrowing books and doing a little teaching. As early as 1756, however, when he was 22 years old, his reputation as a rural intellect began to be known locally, and in the summer of that year three young men about to enter the University of Cambridge went to read with him. The first was John Haygarth, born in Garsdale at nearby Swarthgill (Elliott, 1913). Haygarth in that year was 16 years old and was later to become internationally famous for his work on the epidemiology of infectious disease. The second was a young man called Sedgwick, who became vicar of Dent and the father of Adam Sedgwick, professor of geology at the Univer-

sity of Cambridge and one of Charles Darwin's influential teachers. The third became an obscure clergyman in Leicestershire. Sedgwick, according to his son, spoke of this Garsdale summer with Dawson in 1756 as one of great happiness and profit.

Soon after this Dawson was taken on as an assistant by a Mr. Bracken of Lancaster, a well-known country surgeon and apothecary with a wide and extensive practice. Here Dawson, too old to be a regular apprentice, learned the rudiments of the profession that was to be his livelihood. Later he set up at Sedbergh, the market town at the foot of his native valley and some five miles (8 km.) from his birthplace, as a surgeon and apothecary.

He lived at first a life that was abstemious in the extreme, his purpose being to save up enough money to travel to Edinburgh for further medical study. At the end of that first year, with £100 of hard-earned money stitched into the lining of his waistcoat, he set off on foot for the Scottish capital, where he attended classes in medicine. There he lived in conditions of the sternest self-denial until his funds ran out, and he then walked back to Sedbergh. His popularity in his native dales was such that work flowed to him and he was continuously sought locally. Within another two years he had saved up £300, and with this sum stitched in small parcels of gold in his waistcoat he travelled to London, mostly on foot, but he is said to have done part of the journey by stage wagon, the mode of transport of the poor. London, however, was more expensive than Edinburgh, and he could not live as quietly as he had there, for in London his mathematical abilities were beginning to be recognized. He got through a course of medical and surgical lectures, obtained some sort of a diploma, and then went back to his home at Sedbergh. For the next 20 or 30 years he earned his living as a practitioner in that town, attending the sick, helping the dying, delivering women in childbirth, occupying himself with the manifold duties of the dedicated country doctor. He married Ann Thirnbeck in 1767 when he was 33 and the ceremony was conducted by Dr. Bateman, then headmaster of Sedbergh School. He had one daughter.

Practice in Sedbergh

We know little of his method of practice. But Robert Willan, the dermatologist, who was a pupil of Dawson's before he went to Edinburgh University, refers to him in a letter to his brother Richard, living at the family home at the Hill, near Sedbergh. Dawson was evidently attending Richard Willan, for he was asked to regulate the quantity of Cheltenham or Epsom water that Richard took.‡ Sedgwick, vicar at nearby Dent, called on him in 1785 to deliver his wife of their son, Adam, the geologist who taught Darwin at Cambridge (Clark and Hughes, 1890). John Haygarth, Sedgwick's fellow pupil with Dawson in 1756, gives a case report received from Dawson in 1780 in one of his books on smallpox (Haygarth, 1793a). By now Haygarth was at Chester, developing his plans for exterminating casual smallpox from Great Britain and advising the introduction of general inoculation. It was just a few years before Jenner's discovery. Dawson describes the death from confluent smallpox of a young man called John Airey in a fetid upstairs room in a back street at Sedbergh. His report describes the preventive measures that he took and shows how, despite the fact that many were susceptible, no one else in the town contracted the disease. This is interesting, since it shows that Dawson at that time was following the rules laid down by Haygarth, his fellow dalesman, for the treatment and prevention of infectious fevers. These were the rules that Haygarth later published as his famous *Letter to Dr. Percival on the Prevention of Infectious Fevers*, rules of isolation, cleanliness, and ventilation which have persisted to this day (Haygarth, 1801).

‡ R. Willan, jun., M.S. autograph letter to Richard Willan, undated, library of the Medical Society of London.

In 1790 Dawson relinquished his practice as an apothecary but lived on until 1820, dying a venerable intellectual ruin at the advanced age of 86. He was known, revered, and respected in his native valleys as the local medical practitioner. But it is not for this that he is remembered, but for his mathematics, which won him renown as a remarkable and influential tutor. In many ways it is through his pupils that we know him today.

Mathematical Ability

How Dawson developed his mathematical abilities is not known. He published relatively little, but engaged in controversy with William Emerson, who refused to accept some of Thomas Simpson's work pointing out a slip made by Newton in the problem of precession. Dawson's independent analysis supported Simpson. In 1769 Dawson, the country practitioner, wrote an anonymous pamphlet in reply to a geometrical essay by Mathew Stewart, professor of mathematics at the University of Edinburgh (Dawson, 1769).

Stewart had tried to calculate the distance of the sun from the earth using the theory of gravity, attempting to determine the extent to which the orbit of the moon around the earth is disturbed by gravitational pull in different positions. Dawson's pamphlet was entitled "Four propositions showing not only that the distance of the sun as attempted to be determined from the theory of gravity by a late author is upon his own principles erroneous but also that it is more than probable this capital question can never be satisfactorily answered by any calculus of this kind." Dawson pointed out that the only really effective way of calculating the sun's distance was by a careful observation of the transit of Venus, and it was to do this that James Cook, another Yorkshireman, sailed to Tahiti in that year on his first voyage of exploration. Dawson was proved right in this controversy, and this brought him the friendship and esteem of a wide group of philosophers of the time. He was visited at Sedbergh by the Edinburgh mathematician John Playfair, by Lord Webb Seymour, and by Lord Brougham. His other publications included an analysis of the work of the Reverend C. Wildbore, who had sought to describe the velocities of water issuing from a vessel in motion. Dawson was also interested in theology, and in 1781 published a tract attacking Thomas Priestley's doctrine of philosophical necessity.

Reputation as a Teacher

Dawson's reputation as a mathematical teacher and his method of teaching have been well described by Adam Sedgwick, who was his pupil in 1804. Adam Sedgwick must be considered one of Dawson's most brilliant pupils. It was with Sedgwick, then professor at Cambridge, that Charles Darwin in the summer of 1831 spent several weeks studying rock formations in Wales and making a geological map of the country. In fact on his return home from this trip on 29 August he was greeted with the letter from George Peacock offering him the post of naturalist on the *Beagle*. Darwin once described Sedgwick as a "talking giant," and when he got to Ascension Island on his way home from his epic voyage he related how the news that Sedgwick had said that "Charles Darwin should take a place amongst the leading scientific men" fired him with enthusiasm for geology. "After reading this letter," wrote Darwin, "I clambered over the mountains with a bounding step and made the volcanic rocks resound under my geological hammer" (Moorhead, 1969).

According to Sedgwick, Dawson took students during the summer vacations, and after giving up his practice in 1790 he devoted himself entirely to mathematical teaching. He charged five shillings a week for instruction and would teach for as long as his pupils would learn. His pupils seem to have come from far and wide. Dr. Butler, later headmaster of Harrow, was his pupil in 1792. In a letter he describes his jour-

ney from the south and how he paid one and sixpence a week for an excellent room at the best hotel in town, the Kings Arms. Breakfast was twopence, and dinner for tenpence a day was "a leg of mutton and potatoes both hot; ham and tongue, gooseberry tarts, cheese, butter and bread; pretty well for tenpence." Between 1781 and 1794 Dawson had eight senior wranglers among his pupils, and the senior wranglers for 1797, 1798, 1800, and 1807 were all Dawson's men. One of these was James Inman, another Garsdale man, afterwards mathematical professor at the Royal Naval College and the author of Inman's tables. In addition to these men, Dawson's pupils included John Haygarth and Robert Willan, to whom reference has been made, George Birkbeck and Adam Sedgwick. Such a galaxy of intellectual talent is a remarkable tribute to the abilities of this extraordinary country practitioner.

Whether Dawson was ever on the staff of Sedbergh School as a regular teacher is uncertain. A fair number of Sedbergh boys may well have benefited from his instruction, though only three of his senior wranglers were Sedberghians. He certainly had close links with the school, for the school history records how Dawson wrote a memorandum describing the problems of Dr. Bateman, the headmaster who had officiated at his wedding. "People here," wrote Dawson, "have made free with him. He has twice been pulled by the nose, besides being very rudely treated in other ways." Such was the lot of the eighteenth century schoolmaster.
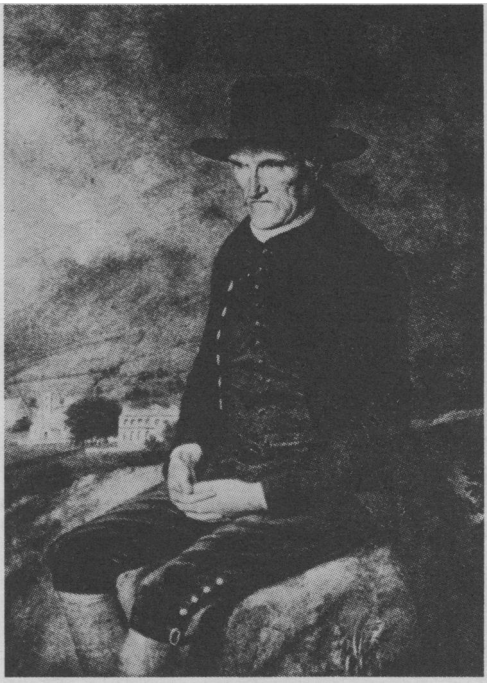
In these days, when mathematics are vital for the analysis of the results of clinical investigation, it is interesting to look back and examine whether Dawson's mathematical abilities were ever applied to the medicine that he practised. We have no record of whether this was so, but his pupil and neighbour from Garsdale, John Haygarth, certainly made use of his ingenuity. In his *Inquiry How to Prevent the Small Pox*, published when he was still working at Chester, Havgarth (1784) records how "It occurred to me that it might be computed arithmetically by the doctrine of chances . . . if one, two or three persons were exposed to the variolous infection, what degree of probability there was that one or more of these would catch the distemper." Dawson calculated the odds for Haygarth on the assumption that 1 person in 20 might be not liable to smallpox. So that if a single child in a family escapes the disorder then the likelihood that he was never exposed is probable is a degree of 19 to 1. If two in a family escape the probability is 400 to 1, and if three escape then the odds are above 8,000 to 1. Later on, when Haygarth had come to believe that it would be possible to exterminate smallpox in the community, Dawson calculated for him the increase in population that might result (Haygarth, 1793b). This was done on the assumption that either 30,000 or 35,000 people might survive annually if the disease was eradicated. The results of Dawson's calculations are given in the accompanying Table.

Conclusion

A portrait of Dawson shows him sitting on a rock with the old Sedbergh school-house, now the school library, in the background (see Fig.). Adam Sedgwick has left us a delightful description of his admired teacher. "Simple in manner," he wrote, "cheerful and mirthful in temper, with a dress approaching that of the higher class of venerable old Quakers of the Dales, without any stiffness or affectation of superiority, yet did he bear at first sight a very commanding presence. . . . His powerful projecting forehead and well-chiselled fea-

John Dawson. From a water-colour drawing by William Westall, 1817, published in *The Life and Letters of the Reverend Adam Sedgwick*, by J. W. Clark and T. McK. Hughes. Cambridge, Cambridge University Press, 1890.

tures told of much thought, and might have implied severity had not a soft radiant benevolence played over his fine old face. . . ." (Sedgwick, 1870).

Dawson died on 19 September 1820 and was buried at Sedbergh. Some years later his former pupils erected a monument to his memory in the church. There the fine black marble bust of John Dawson can be seen today. The inscription was written by John Bell of Trinity, distinguished leader at the Chancery Bar and senior wrangler in 1786, and it reads "In memory of John Dawson of Sedbergh, . . . Distinguished by his profound knowledge of mathematics, beloved for his amiable simplicity of character, and revered for his exemplary discharge of every moral and religious duty."

That simple character, John Dawson, perhaps would not have wished that the 150th anniversary of his death should be marked by the publication of this account of his life. But it serves to illustrate how this remarkable man achieved serenity in the obscurity of medical practice and in the study of mathematics in a remote valley of the Yorkshire dales.

Calculated Increase in Population should Smallpox be Exterminated

Period of Years	Increase of Inhabitants if:	
	30,000 Survive Annually	35,000 Survive Annually
10	281,922	328,909
20	527,694	615,643
30	737,322	860,209
40	910,800	1,062,600
50	1,048,146	1,222,837
60	1,149,342	1,340,899

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