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THE HISTORY OF ANAESTHESIA SOCIETY PROCEEDINGS

Vol 25

Proceedings of the Combined Meeting to mark the Bicentenary of Davy's Researches into Nitrous Oxide

Bristol, 13-15 May 1999

Held jointly with

The Society of Anaesthetists of the South Western Region and

The Anaesthesia History Association

Includes cumulative index Vols 21 - 25

DAVY BICENTENARY MEETING - MAY 1999

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President: Dr Jean M Horton

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President: Dr Theodore C Smith

SOCIETY OF ANAESTHETISTS OF THE SOUTH WESTERN REGION
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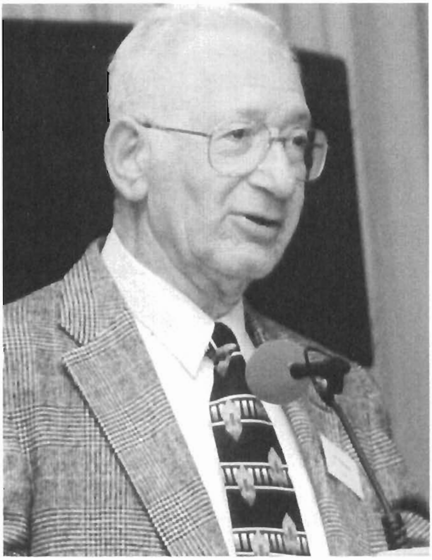

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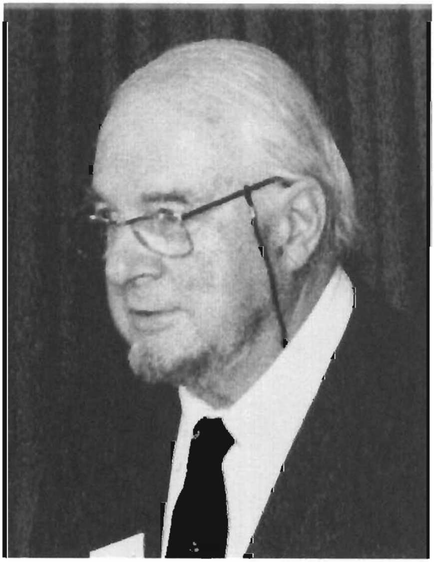

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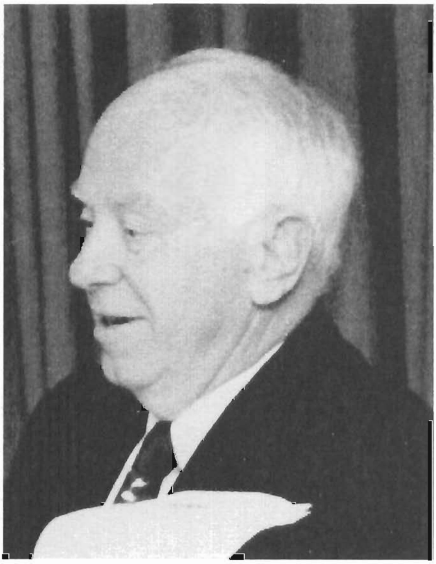

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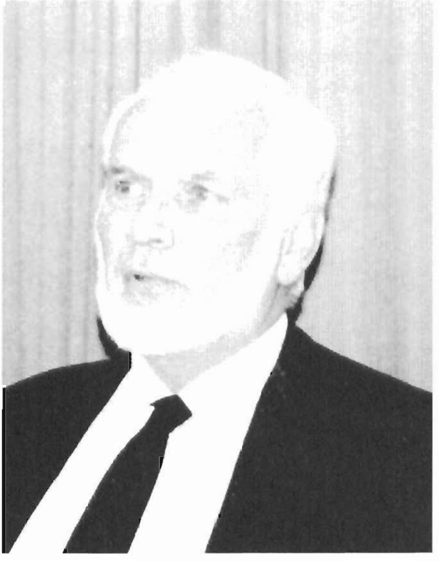

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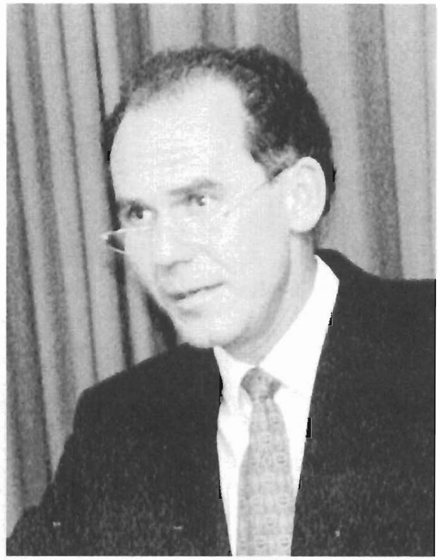

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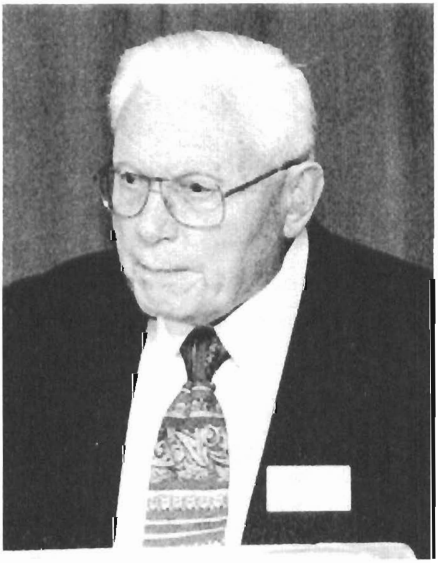

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A COMBINED MEETING TO MARK THE BICENTENARY OF DAVY'S RESEARCHES INTO NITROUS OXIDE

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Volume 25

A CRITICAL RE-READING OF HUMPHRY DAVY'S *RESEARCHES*

Dr N A Bergman
Oregon Health Sciences University, Portland, USA

Humphry Davy arrived at Dr Thomas Beddoes' Pneumatic Institution in early October 1798 and remained there until March 1801. During this interval and at this facility he produced the studies and the book which this meeting celebrates. He then left Bristol for London to take up his new position at the Royal Institution of Great Britain.

Why nitrous oxide?

One interesting question to consider is why he selected the obscure and physiologically unimportant gas nitrous oxide for his extensive and comprehensive studies. In an early publication[1] he had written that although the general role of oxygen in respiration and combustion was well known, ignorance of the specific changes effected in the blood caused by oxygen gas was a considerable source of the imperfection in medicine. Why then did he not study oxygen or, for that matter, one of the numerous other gases which had been identified and characterised by this time? Probably because both he and Beddoes believed that great therapeutic results would be obtained with nitrous oxide, particularly in palsies and various states of depression. It is most likely they interpreted the intense cerebral activity as well as the vigorous and often bizarre motor phenomena occurring during nitrous oxide breathing as resulting from generalised stimulation of the body by the gas. These responses would be of value in paralytic conditions or states of depression and nitrous oxide was extensively evaluated in patients with these types of conditions.

Effects of nitrous oxide

Davy first observed the peculiar effects of nitrous oxide on the nervous system in April 1799. He wrote a letter to William Nicholson, editor of a popular scientific journal, dated Clifton, April 17, 1799:

> 'I have this day made a discovery, which, if you please, you may announce in your *Physical Journal*, namely that the nitrous phosoxyd, gaseous oxyd of azote, is respirable when perfectly freed from nitric phosoxyd (nitrous gas). It appears to support life longer than common air, and produces effects which I have no time to detail at present. Dr Mitchill's theory of contagion is of course completely overturned; the mistakes of Priestley and the Dutch chemists probably arose from their never having obtained it pure.'[2]

Several points related to this letter are worthy of comment:

1. The 'effects which I have no time to detail at present' were no doubt the surprising mental and motor responses to nitrous oxide which were unequivocally demonstrated for the first time on this day.

2. Davy's emphasis that the observations had been made 'this day' firmly fixes the date. Arguably 17 April 1799 might be worthy of nomination as the start of the discovery of anaesthesia, and 1999 has seen its bicentenary.

3. The word respirability was used differently by Beddoes and Davy. To the senior and experienced Beddoes, respirable gases were only those which were capable of supporting life: atmospheric air or oxygen. To Davy, any gas which could be voluntarily inspired into the lungs was respirable. This optimism led to Davy's injurious and possibly near fatal attempts to breathe nitric oxide and carbon monoxide.

Purity of the gas

What motivated Davy to intensify his studies involving the breathing of nitrous oxide? He wrote:[3]

> 'In April, I obtained nitrous oxide in a state of purity, and ascertained many of its chemical properties. Reflections upon these properties and upon the former trials, made me resolve to endeavour to inspire it in its pure form, for I saw no other way in which its respirability, or powers could be determined.'

The availability of pure nitrous oxide in relatively large quantities in April 1799 probably signifies the beginning of the use of Berthollet's method of obtaining the gas by gentle heating of ammonium nitrate. The former trials to which Davy referred were done with nitrous oxide prepared by treating zinc or copper with nitric acid. The resulting gas was very impure and contained large amounts of nitrogen and nitric oxide. It was used as late as March 1799. Thus the capability of obtaining large quantities of pure nitrous oxide in mid April 1799 marked a turning point in Davy's researches.

One wonders why Davy did not implement inhalation anaesthesia while he was at the Pneumatic Institution, when he appears to have been in possession of all the information and equipment to do so. Some of his apologists have explained this failure on his being a physical scientist who could hardly be expected to pay much attention to medical and surgical problems. But before he arrived at the Institution he had been serving as an apprentice surgeon apothecary and was thus partly trained as a medical practitioner. He had assisted at and personally performed surgery and should have been thoroughly familiar with pain and suffering during operations. He never gave up his desire to practise medicine, and as late as about 1807 was still considering abandoning chemistry for medicine.

Appropriate vocabulary

While at the Pneumatic Institution, Davy tells us that he spent ten months doing his nitrous oxide experiments as described in his *Researches* and an additional three months in writing. One of the difficulties he encountered was in finding appropriate descriptive terms and other vocabulary to present and discuss the new and unexplored field. In the introduction he wrote:

> 'In consequence of the discovery of the respirability and extraordinary effects of nitrous oxide, or the dephlogisticated nitrous gas of Dr Priestley, made in April 1799, in a manner to be particularly described hereafter, I was induced to carry on the following investigation concerning its composition, properties, combinations, and mode of operation on living beings. In the course of this investigation, I have met with many difficulties; some arising from the novel and obscure nature of the subject, and others from a want of coincidence in

the observations of different experimentalists on the properties and mode of production of the gas'.[4]

This observation by Davy concerning the difficulties of finding suitable terminology and concepts to discuss a new field of knowledge invites comparison with a similar statement made by another pioneer. John Snow, in his book on ether published almost half a century later, commented on the same problem:

'The inhalation of ether will, no doubt, have superior works to the present dedicated to its elucidation before long, not only from increase of knowledge respecting it, but from improved ways of treating on it, for it is not easy to reduce a new branch of science to suitable language in the first attempts.'[5]

Davy and Beddoes

Another interesting particular to consider is the change in tone of Davy's acknowledgement of the role of Beddoes during the period they worked together in Bristol. An early dedication from one of Davy's laboratory notebooks reads:[6]

'Dedication to Thomas Beddoes MD
'I know of no one to whom I can with so much propriety dedicate this work as to you. There are few persons to whom I have greater obligations. The hopes awakened in my mind by your observations on Chemical Physiology were among the motives that induced me thirty months ago to begin the study of Pneumatic Chemistry. Without you the Researches detailed in this volume would probably never have been made. Receive them as pledges of more important labours in that infant Science which your benevolent and philosophical exertions have so much contributed to enlarge.....and believe me be with respect and affection. Your friend Humphry Davy'

But when Davy's *Researches* were published a few months later the dedication to Beddoes had shrunk to a brief acknowledgement:[7]

'I cannot close this introduction, without acknowledging my obligations to Dr Beddoes. In the conception of many of the following experiments, I have been aided by his conversation and advice. They were executed in an Institution which owes its existence to his benevolent and philosophic exertions'.

What caused this abrupt revision of Davy's expression of his obligation to Dr Beddoes? Probably it was occasioned by Davy's concern about continuing criticism of Beddoes for some of his more outrageous scientific and medical theories and also for his religious heterodoxy and political opinions and actions. Beddoes characterised individuals who carried on such criticism as 'certain British literary ruffians, who engage by the day, or the week, or the month to assassinate literary reputations on account of delinquencies not literary'.[8]

Beddoes had encouraged early publication of certain of Davy's theories, chiefly concerning light and heat in chemical reactions, which Davy almost immediately wished had not appeared in public. Perhaps the change in the dedication of *Researches* was an attempt to distance himself from the controversial Dr Beddoes. Still, they stayed friendly for the remaining eight years of Beddoes' life.

Davy's notebooks

Davy's laboratory notebooks, from which the first, effusive quotation was taken, do not permit precise dating of most of the material contained therein, including the dedication. He appears to have used several laboratory notebooks simultaneously. When he wished to make a notation, it seems he just seized the closest book, opened it in the direction in which it happened to lie in his hand, found the first empty page and began writing. Few notes are dated and many of the books can be read either front to back or back to front. These peculiarities were quite in accord with descriptions of his seemingly disorganised conduct in the laboratory as related by his biographer, John Ayrton Paris:

> 'It was his habit in the laboratory, to carry on several unconnected experiments at the same time and he would pass from one to the other without any obvious design or order: upon these occasions he was perfectly reckless of his apparatus: breaking and destroying a part in order to meet some want of the moment. So rapid were all his movements, that while a spectator imagined he was merely making preparations for an experiment, he was actually obtaining the results, which were just as accurate as if a much longer time had been expended. With Davy, rapidity was power'.[9]

Nevertheless, the crafty and actually methodical Humphry Davy accomplished a huge quantity of work at the Pneumatic Institution and the book that he wrote there describing his researches stands as a great milestone in the development of anaesthesia.

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HUMPHRY DAVY, NITROUS OXIDE, LUNG VOLUMES AND ELECTIVE AFFINITY

Dr D Zuck
Past President, History of Anaesthesia Society

On n'est pas tous nés pour ouvrir les fenêtres
Mais beaucoup sont nés pour être asphyxiés.
(Not everyone is born to open windows
But plenty are born to be asphyxiated.)
Henri Michaux - Qui je fus: l'époque des illuminés.

The second half of the eighteenth century would have been a very exciting time for anyone interested in chemistry. Starting in 1754, when Joseph Black (1728-1799) commenced his researches into carbonates and alkalis, devised the lime water test for what he called fixed air (carbon dioxide), and showed that it is exhaled in the breath, the discovery of different gases, and the ability to distinguish between them developed rapidly. Henry Cavendish (1731-1810) identified and studied what he called inflammable air (hydrogen) in 1766. Daniel Rutherford (1749-1819) in 1772, showed that if carbon dioxide was removed from 'vitiated' air - air from which the oxygen had been removed by respiration or combustion - there was a residue which he called noxious air, (azote, nitrogen). Joseph Priestley (1733-1804), according to WDA Smith's chronology,[1] prepared nitrous oxide in late 1773, prepared and recognised oxygen in 1774 after missing it earlier, and worked out his quantitative test for it, for its 'goodness', by which he meant its ability to support life or combustion, reacting it with 'nitrous air' (nitric oxide), to produce the brown fumes of water-soluble nitrogen peroxide. Because nitrous oxide supports combustion he did not distinguish between it and oxygen for some six months.

All these discoveries were interpreted in terms of the phlogiston theory, which held that combustion was the giving off of this mysterious, gravity-defying substance, which pure metals contained but oxides did not. But in 1777 Lavoisier (1743-1794) formulated his hypothesis that combustion was essentially combination with oxygen; and from his ice-calorimeter experiments of 1782-83 he drew an analogy between combustion and respiration.

Respiration was the slow combustion of carbon carried in the venous blood as a waste product from the tissues, and oxygen. It took place in the lungs, and was the source of the body's heat. Then, in 1787, after some five years of deliberation, a committee consisting among others of Lavoisier, Guyton de Morveau, and Fourcroy, proposed a major reform in chemical nomenclature, and laid the foundation of the present system. All this, together with advances in apparatus and technology pioneered by Cavendish, Priestley, and others, was included in Lavoisier's great textbook, published in 1789, in which more than one hundred pieces of apparatus were illustrated. We know that Humphry Davy began to read this book in French in 1795, during his apprenticeship to Borlase in Penzance. So this, very briefly, was the chemical world in which Davy began to make his mark.[2]

Beddoes and Watt

The medicinal use of the so-called factitious airs appears to have started in the Midlands in the early 1790s, and was taken up by Thomas Beddoes (1760-1808) at the suggestion of several friends, among whom were Joseph Priestley and Erasmus Darwin (1731-1802).[3] On 17 July 1793, James Watt (1736-1819) wrote to his great friend, Joseph Black:

> 'We have no philosophical news since the affair of the frogs electricity except that Doctor Beddoes is applying the antiphlogistic Chemistry to Medicine Azote and other poisonous airs to cure Consumptions and oxigene for spasmodic asthmas. He is at Bristol wells (sic) for the greater practice.'[4]

This appears to be the first mention of Beddoes' involvement with pneumatic medicine.[5] The rationale, or a rationale, because Beddoes always seemed to be hedging his bets, was that in consumption the tissues were being consumed at an excessive rate, which he attributed to a hyperoxygenated state of the body. Hence 'lowering' or diluting atmospheric air with, for example, hydrogen, nitrogen, or carbon dioxide, should be beneficial, although the choice of hydrogen for use as a fire extinguisher seems questionable, to say the least.[6] But Beddoes being also a strong Brunonian, there was always the alternative explanation that the gases worked as either stimulants or sedatives. Bristol Hotwells was chosen, as Beddoes explained in his letter to Darwin, because invalids congregated there, and would furnish patients in all gradations of the disease.[7] Watt's subsequent letters to Black contain progress reports, and describe his own part in the development of apparatus.

In 1794, Beddoes and Watt published a small tract on the subject: *Considerations on the Medicinal Use, and on the Production of Factitious Airs.* Beddoes gave an account of the chemistry and physiology of the gases, and Watt described the apparatus he had designed for preparing, storing, and administering them.[8] Beddoes began by explaining that the atmosphere consisted of two kinds of air, the one called vital, dephlogisticated, or oxygene, which supports flames and turns black venous blood red, and the other called azote, phlogisticated, foul or bad air, which extinguishes flames, does not alter the colour of venous blood, and does not react with lime water. These two are present in atmospheric air in the proportion of about 27% oxygen to 73% azote. (These erroneous figures were taken from Lavoisier, and accepted also by Davy, rendering much of his quantitative work incorrect.) Beddoes goes on to say that there must be 'a nice balance of attraction' between the two, because although azote, or nitrogen, is lighter than oxygen, they do not separate in the atmosphere, but nor do they combine so closely as to form nitrous acid (nitric oxide), which was already known to consist of nitrogen and oxygen. This question of the chemical state of the atmosphere, whether it was a compound or a mixture of elements, was a key one, and continued to puzzle chemists for some years.

Watt's apparatus consisted of an alembic, or cast iron pot, in which the reacting chemicals were heated in a furnace; a refrigeratory, in which the resulting gas was cooled; and a pneumatic bellows, or gas holder (Figure 1). This consisted of a base, two concentric metal cylinders with water in the space between, and the counterbalanced container, a closed metal bell with an inlet for the gas, which floated in the water seal. The interesting feature of the refrigeratory was that it contained a spiral channel through which the gas flowed, and this feature was later adopted by Julius Jeffreys for one of his humidifiers, and by John Snow for his ether vaporiser. It is possible that Jefferys was acquainted with this book, because he also used the very unusual word 'refrigerator' for one of his cooling devices.[9] The apparatus was

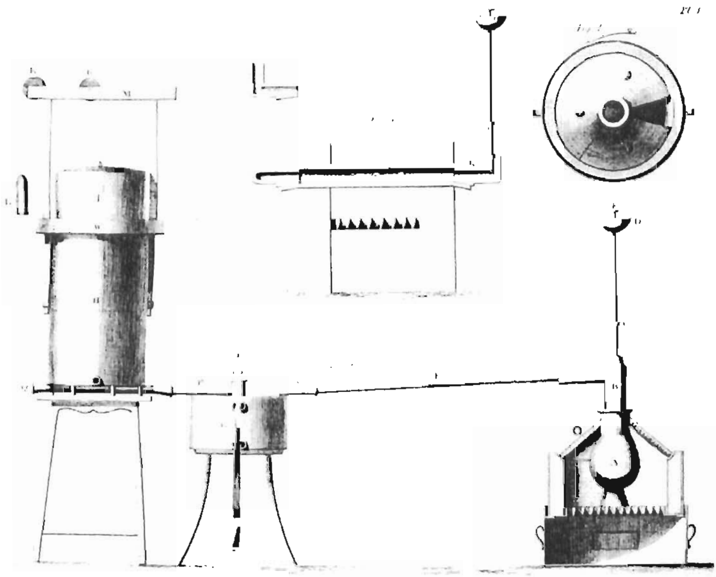

Figure 1. Watt's apparatus

available commercially, being manufactured by the firm of Boulton and Watt in several sizes for domestic use, and on 1 June 1796 Watt despatched a small one to Black.[10] Various gases could be prepared. Carbon dioxide from vinegar acting on chalk; oxygen from Exeter manganese and sulphuric acid; and hydrocarbonate, which was probably mainly carbon monoxide and some methane, from the reaction of water with very hot charcoal. Because hydrocarbonate was inflammable it was often confused with hydrogen, notably by Watt in his dispute with Cavendish over the composition of water.

The tract did well. The first edition, of 500 copies, was sold out in a few weeks, and a further impression was required. During the next two years two more editions were published, and it had grown to a book in five parts, of some 500 pages. The third edition contained a large number of reports of clinical trials of the various gases. There was also a prospectus for the proposed Pneumatic Institute, a list of subscribers, and an appeal for more. There was an account of some animal experiments, and the opinion that oxygen is dangerous, because 'it increases the internal motions so as to produce dangerous or mortal inflammation', and that hydrocarbonate is extremely deleterious. There are several tables of conditions treated, which include asthma, chlorosis, dyspepsia, epilepsy, palsy, pneumonia, croup, and typhus. The indications had obviously expanded. But in the preface Beddoes was on the defensive. He was being attacked for persisting in his plan for a pneumatic institute, in spite of the failure of the very many clinical trials to produce any cures. His response was that it was because pneumatic medicine had not proved an unequivocal success, that there was the need for a research institute.

Two large benefactions received in 1797 allowed the Pneumatic Institute to be set up, and Humphry Davy (1778-1829) was engaged as its medical superintendent. He had already declared, most poetically, his philosophy of the application of science to medicine:

> 'Chemistry, which arose from the ruins of alchemy, to be bound in the fetters of phlogiston, has been liberated, and adorned with a beautiful philosophic theory. The numerous discoveries of Priestley, Black, Lavoisier, and the other European philosophers in this branch of science, afford splendid proofs of the increasing energies of the human mind. From the application of chemistry to the discovery of the laws of organic existence, mankind had hoped to derive the greatest advantages; from this source they expected the perfection of physiological science; but their hopes have been in great measure frustrated.'

Except for the therapies of Dr Beddoes, chemistry had afforded little assistance to the care of diseases. Ignorance of the composition of organic matter, and of the changes effected in the blood by oxygen gas were, he thought, the considerable source of the imperfection of medicine.[11]

Davy on respiration

Davy had already published a theory of respiration, appended to his early essay on heat and light.[12] Contemporary chemical theory postulated the existence of a peculiar elastic fluid, the substance of heat, named caloric by Lavoisier, which insinuated itself between the corpuscles of a substance, separating them from one another, and accounting for the repulsion which was necessary for a gas to exist. Hence, carbon dioxide gas was carbon dioxide+caloric. Without caloric, carbon dioxide was 'fixed', within a carbonate. The addition of caloric, as heat, released it as a gas. Similarly, oxygen gas was oxygen+caloric. But Davy, experimenting with a gun lock in an evacuated container, showed that while the impact of flint on steel still produced heat, no spark was to be seen. When oxygen was restored, the spark returned. Hence, he argued, it was not heat but light which was the essential ingredient of oxygen gas, and coined the name phosoxygen for it. Within two years he repudiated this idea as 'infant chemical speculations', and the twelve page essay on respiration, which deserved a much better fate, went into limbo with it.[13] In this essay, although arguing from the wrong premises, he showed, for the first time, that venous blood contains both oxygen and carbon dioxide, and he placed the metabolic reaction which produces the latter, and the accompanying water vapour, not in the lungs, as postulated by Lavoisier, but elsewhere in the body.

Davy's Researches

So Davy found himself head of a well-equipped and busy establishment, which at one time had more than 80 out-patients on its books. But in addition to his medical work, either on his own initiative or at the suggestion of Beddoes, he began to study nitrous oxide. The well-known book in which he described this work, *Researches, Chemical and Philosophical; chiefly concerning Nitrous Oxide or Dephlogisticated Nitrous Air and its Respiration*, was published in the summer of 1800. It contains some 600 pages, and is divided into four main sections, entitled Research 1, 2, 3, and 4. Each Research is divided into two or more Divisions. The first two Researches deal with chemistry, while Researches 3 and 4 are concerned mainly with the effects on animals and man of breathing nitrous oxide. The accounts which most people are familiar with, the widely cited descriptions of the psychological or mental effects of inhalation by a number of Davy's well-known friends, occur in Research 4. What is notable is the paucity of case reports on the medicinal use of nitrous oxide, four pages out of almost six hundred. According to the Brunonian system it was a stimulant; at one time Beddoes thought it was a more powerful form of oxygen, so it was used principally for the treatment of palsy.

The main subject of this paper is contained in Research 3, and reading it one can immediately see that Davy wrote the book back to front. He starts Division 2 of Research 3 as follows:

> 'As soon as I had discovered that nitrous oxide was respirable, and possessed of extraordinary powers of action on living beings, I was anxious to be acquainted with the changes effected in it by the venous blood. To investigate these changes, appeared at first a simple problem; I soon however found that it involved much preliminary knowledge of the chemical properties and affinities of nitrous oxide.'[14]

He continued that it was only after he had started at the beginning and completed the researches described in the first part of the book that he was able to take up again his enquiry into the mode of action and effect of nitrous oxide on living beings. But the discovery that nitrous oxide is respirable is not related until the beginning of Research 4. As is well known, Davy was concerned to refute the theory of the American, Dr. Mitchill, that nitrous oxide, then known as dephlogisticated nitrous gas, and called by Mitchill 'oxide of septon', was highly poisonous. Mitchill asserted that it was, in fact, the principal agent of contagion, capable of producing, as Davy says in a footnote, 'the most terrible effects when respired by animals in the minutest quantities or even when applied to the skin or muscular fibre'. He continues that 'the fallacy of this Theory was soon demonstrated, by a few coarse experiments.' A small quantity of nitrous oxide was prepared, wounds were exposed to it, animals were immersed in it without injury, and he himself breathed it in small quantities mixed with common air, without remarkable results. This was in March 1798, and to Davy goes the credit for demonstrating that nitrous oxide is respirable, and for describing its mental effects. But it was only at the beginning of March of the following year that he was able to prepare a quantity of nitrous oxide large enough to be breathed for any length of time, and not until a month later did he have it in a sufficiently pure form to be able to study its chemistry and physiological actions.

The remainder of Research 4 is taken up with descriptions of Davy's sensations on breathing nitrous oxide, and those of his friends: the thrilling, light-headedness, and the exhilaration. Since other papers will be dealing with these, I will just make one observation. Culminating his account of having breathed nitrous oxide very frequently, often several times a day, over a period of some weeks, Davy says: 'I ought to have observed that a desire to breathe the gas is always awakened in me by the sight of a person breathing, or even by that of an air-bag or an air-holder'.[15] Dr Cartwright comments that 'Davy had, in fact, become a nitrous oxide addict, a form of addiction which, though rare, is occasionally met with today'. And he continues that Davy appears to have broken himself of this habit easily after he moved to the Royal Institution.[16] But the thing about nitrous oxide is that, unlike the agents we commonly think of as drugs of addiction, it does not create a physical dependence. The significance of Davy's sentence does not seem to have been grasped - that the desire to inhale is only awakened by the immediate availability of the gas, nowadays, of course, not in an air-bag but in a cylinder. So when dealing with nitrous oxide addiction it is possible to be lulled into a false sense of security by the absence of the craving in the physical absence of the gas. Once Davy had moved to the Royal Institution and to a different field of research, in the absence of the trigger, the so-called addiction disappeared.

Elective Affinities

But why, of all gases, choose nitrous oxide? It had a very limited application as a therapeutic agent, and its use as a general anaesthetic was nowhere in question. We have already seen that there was considerable interest in whether the atmosphere was a compound or just a mixture of gases. Most chemists thought it was a compound, with, in Beddoes' words: 'a nice balance of attraction', or to use the expression then in vogue, 'of affinity' or 'elective affinity' between the constituents. The idea that certain elements are more likely to combine with each other than with others goes back to the thirteenth century.[17] Reactions in which one element replaces another in a compound had been studied by Boyle, and in 1718 the French chemist Geoffroy had published a table in which he listed the affinities of various substances. During the 1760s and '70s the Swedish chemist Bergman studied the ability of metals to displace one another from salts: for example, copper would displace silver from silver nitrate, lead would displace copper from copper nitrate, and zinc would displace lead from lead nitrate. Towards the time when Davy was commencing his researches, some leading chemists, including Kirwan, Macquer, and Guiton de Morveau, were intensely interested in the idea, and the subject was so topical that Goethe used it as the theme of a tragic novel about marriage, adultery, obsessional attraction, and determinism or free will in personal relationships, whose title translates as '*Elective Affinities*'.[18]

Davy having refuted Mitchill's theory, now had a respirable gas which, like atmospheric air, was composed of nitrogen and oxygen, and which, also like air, supported combustion. During combustion it obviously dissociated, like air, into oxygen and nitrogen, and since Lavoisier had drawn an analogy between combustion and respiration, the question was, did it also dissociate and make its oxygen available in the body? Or was the affinity between nitrogen and oxygen greater in nitrous oxide than in air? When we read Davy's approach to this question we realise that he does not relate the sequence of events as they actually occurred. If the last chapter of the Researches, in which the refutation of Mitchill is described, had come first, it would be much easier to follow the line of reasoning and to see what was going on.

In the second section of Research 3, Davy described how analysis of the contents of a bag of nitrous oxide, after he had breathed in and out of it for some time, showed that it was mainly nitrogen. His first conjecture was that nitrous oxide 'was decomposed in respiration in the same manner as atmospheric air, and its oxygene only combined with the venous blood'.[19] This was in line with the belief that atmospheric air, also, was a compound of nitrogen and oxygen. So to determine whether nitrous oxide was decomposed during respiration he embarked on a number of in vitro experiments, using blood obtained by venesection. Great difficulty was caused by coagulation, but he was able to conclude, firstly, that fluid venous blood will absorb nitrous oxide, changing in colour from dark red to red purple, and giving off small amounts of nitrogen and carbonic acid (carbon dioxide); and secondly, with hindsight, essential for the use of nitrous oxide in anaesthesia, that venous blood impregnated with it is capable of oxygenation, and conversely that oxygenated blood will combine with it.

These experiments convinced him that his original idea that nitrous oxide decomposes into nitrogen and oxygen during respiration was an error.

He then tried to confirm in vivo what he had found in vitro - in his own words: 'to ascertain whether the changes effected in nitrous oxide by the circulating blood acting through the moist coats of the pulmonary veins of living animals, were highly analogous to those produced in it by fluid venous blood removed from the vessels' but he found this extremely difficult. Animals small enough to be put into the mercurial apparatus died very quickly - further evidence, if any were needed, that nitrous oxide did not give up its oxygen in the body - and before they died they absorbed and gave out so little gas that it was useless to analyse the residue. So he started to use himself as the experimental animal, at first breathing from a bell glass suspended in water saturated with nitrous oxide. He found that after only a few breaths there was a considerable diminution in volume, and the lime water test showed that carbon dioxide had been formed. He realised that some of this had dissolved in the water, and also that dissolved nitrous oxide was being given off to replace what had been absorbed, so that 'it was impossible to determine with the least accuracy, the quantities of products after respiration'. He found also that breathing into oiled silk bags, even when apparently airtight, was not reliable, so he was obliged to resort to the large mercurial airholder (Figure 2) which he had used for the chemical experiments described in the first part of the book.

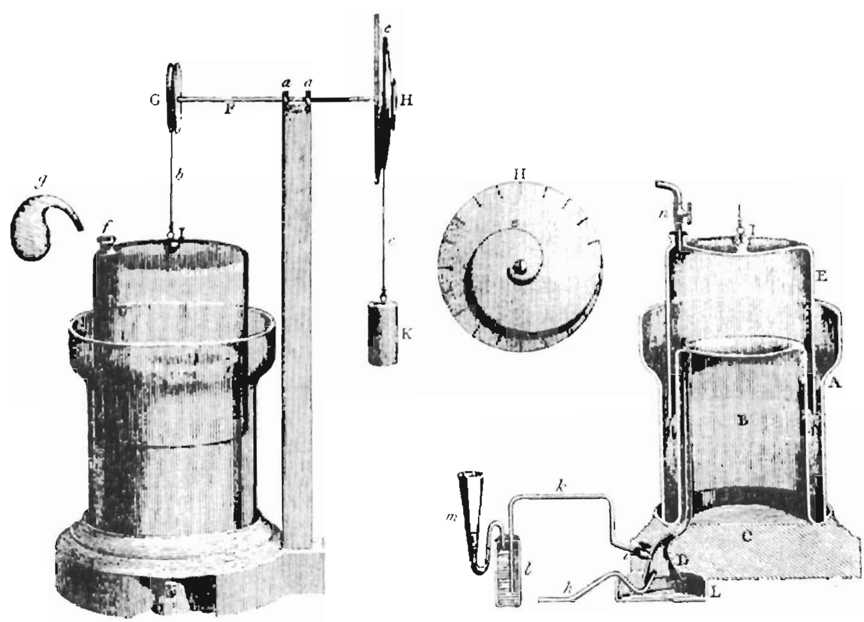

Figure 2. Clayfield's mercurial gasholder

This had been constructed for him by William Clayfield, and was based on the apparatus designed by James Watt. William Clayfield was the son of Michael Clayfield, distiller, of

Castle Street, Bristol, the benefactor of the Bristol poet Thomas Chatterton. He worked as the laboratory assistant at the Pneumatic Institute, had some chemical training, and in the opinion of Gregory Watt was a profligate in need of reform.[20] But Davy regarded him as a valued friend, and continued to correspond with him for at least the next twelve years. He commented with admiration on Clayfield's work on phosphorescence, and hoped that 'this ingenious chemist' would soon publish an account of it.[21] Later, he mentioned that 'Clayfield is at this moment chiefly engaged in commercial speculations. He has found a new way of making soda, which there is every reason to believe will turn out profitable'.[22] Clayfield also identified a deposit of strontium sulphate near Bristol, which established a local industry.

Unlike Watt's apparatus, which was metal, Clayfield's was made of glass, presumably to allow small creatures to be observed if placed within, and also to avoid reaction between metal and the mercury. Imagine three jam jars. The smallest is inverted inside the largest, and cemented to its base. Mercury is poured between them, and the intermediate jar, also inverted and counterpoised, and with an inlet for the gases, is suspended in the mercury. Clayfield arranged the track of his pulley in the shape of a spiral, and was able to calibrate it to indicate the volume of the contents of the bell. Davy added a modification which allowed him to draw off samples of the gases during any phase of respiration as they flowed from the subject to the bell.[23]

He started his experiments, and noticed, on beginning to breathe in and out of the gasholder, that the volume of nitrous oxide in the bell diminished considerably, especially during the first four or five breaths. He analysed the residual contents of the bell, firstly removing the carbon dioxide by caustic potash, then any nitrous oxide by shaking with a large volume of water. The residue was held to be a mixture of nitrogen and oxygen, and the oxygen was removed by Priestley's method of adding nitrous air (nitric oxide), and dissolving the resulting brown fumes of nitrogen dioxide in water. At each stage in the analysis the change in volume was noted, and finally Davy calculated the composition of the residual gases, and attempted to allow for the change from body to room temperature. Taking what he called his best result, and expressing it in percentages, he found after breathing in and out for half a minute, that the bell, which originally was full of 100% nitrous oxide, now contained 46.9% nitrous oxide, 5.2% carbon dioxide, 6.6% oxygen, and 41.4% nitrogen. Obviously these last three gases had come from himself, and Davy now wanted to determine whether they were just the residual gases in the lungs, or were produced by a chemical change which took place in the lungs during respiration.

He tried several ways of determining the composition of the residual lung gases, and then realised that 'it was impossible to ascertain their quantities ... unless I could first determine the capacity of my lungs; and the different proportions of the gases remaining in the bronchial vessels after a compleat expiration, when atmospheric air had been respired'. He had already found that while rebreathing hydrogen, virtually none was absorbed, and that the residual gas was mixed with some nitrogen, and small quantities of oxygen and carbon dioxide. So he reasoned that if he made a full exhalation, took six or seven breaths of hydrogen, then again breathed out as fully as possible, the proportion of the gases in the airholder would be the same as in the lungs and air passages. So all he would have to do is analyse those proportions, and make his calculations accordingly.[24]

Measuring residual volume

Having been first taught about this method in about 1940, and puzzled over it, intermittently, for the next 59 years, I can now assert, the penny having at last dropped, that the principle is easily explained. Imagine that you have a large bag containing several hundred marbles, either all one colour, or a mixture of any colours except red. You want to know how many there are, but for some reason you are unable to count them. So you introduce a known, reasonably substantial number of red marbles, say fifty, into the bag, and mix very thoroughly. You then take out a number of samples, say five sets of ten, and you find that on average for every red marble there are nine of other colours. So your multiplication factor is nine. Since you put fifty red marbles into the bag, and there are nine of other colours for each red one, the total of other coloured marbles is nine times fifty. Now, Davy's red marbles were hydrogen molecules, and the calculation was slightly more complicated because some were left in the gasholder, but he could measure their volume, and the difference between that and the total he started with was what was in the lungs. Davy describes his results using this method - (accepted normal values in brackets - 1 cu in = 16.4 cc):

Expiration after: a full voluntary inspiration (vital capacity) 190 cu in = 3166 cc (4000 cc);

a natural inspiration (expiratory capacity) 79 cu in = 1280cc. (1500 cc);

a natural expiration (expiratory reserve) 68 cu in = 1115cc (1000 cc);

so:

exhausted lung capacity (residual volume) 41 cu in = 672 cc (1000 to 1500 cc.);

volume of respiratory passages (dead space) 32 cu in = 525 cc (150 cc).

He attributed his low residual volume, which he regarded as below average, to the shape of his chest, which was narrow, being only 29 inches in circumference, and he speculated as to whether it might be possible to find a standard ratio between the various volumes, so that it would only be necessary to make a single measurement, from which the rest could be calculated.

Knowing his own residual volume he recalculated much of his experimental data, and reached the conclusion that a small quantity of nitrogen was produced when nitrous oxide was absorbed during respiration. It then remained to determine whether this nitrogen was evolved from the blood, or whether it was the result of the decomposition of some of the nitrous oxide. The decomposition hypothesis was not supported by what Davy called analogical evidence, since to decompose nitrous oxide in vitro required a high ignition temperature, and he could not see that process starting at the body temperature of 98°F. He found it easier to believe that with the immense quantity of nitrogen taken into the blood in nitrous oxide the system became overcharged, so that excess nitrogen was liberated through the moist coats of the veins. There is some confused thinking here, because he appears to envisage the dissociation of the nitrous oxide, and although it seems also that he was on the track of Henry's Law, he does not enunciate it clearly. But even more telling was an experiment during which he breathed in pure nitrous oxide, and collected and analysed successive exhalations. He found that the quantity of nitrogen decreased with each breath, the opposite of what one would expect if the nitrous oxide was being broken down. Arising from this work, the phenomenon of nitrogen washout was demonstrated conclusively by Allen and Pepys in their two classic papers some eight years later.[25]

Davy goes on to discuss carbon dioxide, which he had already shown to be present in venous blood. He assumes that it will be produced in proportion to the amount of oxygen consumed, and again he concludes that it is impossible for all the carbon dioxide to have been produced by a reaction between charcoal in the venous blood and the oxygen of the residual air while actually in the lungs. So being already present in the venous blood, it must have been liberated through the moist coats of the vessels. And the same consideration applies to the moisture in the breath, which could not have been formed in the lungs by the decomposition of nitrous oxide. Regular readers of the *Proceedings* will recognise all this as an aspect of the debate about the source of body heat which was in progress at this time.[26]

The last section which is devoted to the chemistry of nitrous oxide discusses the respiration of atmospheric air, and of oxygen:

> '... considering atmospheric air as a compound in which principles identical with those in nitrous oxide existed, (i.e. nitrogen and oxygen), though in different quantities and looser combinations, I was anxious to compare the changes effected in this gas (i.e. air) by respiration, with those produced in nitrous oxide and oxygen.'

He mentions that Lavoisier had proved that oxygen is consumed during respiration and carbon dioxide produced, and that Priestley had shown that nitrogen also is absorbed into the venous blood. He then describes a number of experiments in which he breathed in and out of the mercurial gasholder, and analysed the contents. He also enclosed mice, and analysed the residue after they had lost consciousness. His conclusion was that:

> 'the whole compound atmospheric air passing through the moist coats of the vessels is first dissolved by the serum of the venous blood, and in its condensed state, decomposed by the affinity of the red particles for its oxygene; the greater part of the nitrogene being liberated unaltered.'

And since the volume of carbon dioxide produced is always less than the volume of oxygen taken it, it follows that some oxygen must be constantly combined with the red particles.[27]

Finally, he sums up his chemical observations on the respiration of nitrous oxide. It is rapidly absorbed by the circulating blood, and distributed over the whole of the system; but concerning its action upon the nervous and muscular fibres it would be easy to form theories, but it is useless to reason in the present state of our knowledge.

Conclusion

Summing up, when we cut away the preliminary research which Davy found necessary to provide the platform from which to launch his enquiry, we see that the goal of the first three quarters of the book is essentially to elucidate questions of chemical affinity. While we in hindsight tend to regard Davy as having with great prescience researched a gas which was destined to become a general anaesthetic, he regarded himself as investigating a chemical analogue of atmospheric air. According to contemporary belief, atmospheric air was a loosely bound compound of nitrogen and oxygen. Nitrous oxide also was a compound of nitrogen and oxygen, which was known to support combustion in the same way that oxygen does. A lighted spill burns in both gases, but only air supports life. What Davy was trying to understand, in the light of the contemporary idea that respiration also was a form of combustion, was the difference between the affinity between nitrogen and oxygen in air, and nitrogen and oxygen in nitrous oxide. Whereas with other substances different elements would displace one another, here there seemed to be a difference of affinity between the same two elements. How could they in the one instance form a loosely bound compound, and in the other a tightly bound compound? This question was answered within the next few years by John Dalton (1766-1844), who showed that air is indeed a mixture.[28]

But Davy's method of measuring the residual volume, although not the first,[29] remained the standard laboratory technique, though modified and refined by Van Slyke, for the best part of the next two hundred years,[30] and his chemical researches at the Royal Institution continued to be concerned with affinity.

His work, begun in Bristol, using an electric current to dissociate various compounds and obtain pure elements such as potassium and sodium, brought him to the conclusion that chemical affinity was an electrical phenomenon, that combining substances carried opposite charges which became neutralised when they united.[31] This was the subject of his Bakerian Lecture of 1806.[32]

So whereas Davy's biographers have all regarded his chemical researches into nitrous oxide as an isolated endeavour, it is possible to detect an underlying pattern which links this earlier work with his later researches into the nature of the chemical bond.

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GARDNER QUINCY COLTON'S 1848 VISIT TO MOBILE, ALABAMA

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'Dr. Colton offers the closing exhibition of the Laughing Gas for Ladies and Gentlemen this evening, at the Alhambra. Ten gentlemen and four ladies will inhale the Gas, presenting a double attraction.' [1]

The origins of public scientific demonstrations

Across Europe during the eighteenth century science became increasingly embedded in public spaces. Early in that century, in England: 'Such entrepreneurs as Jean Theophilus Desaguliers and Francis Hawksbee pioneered the presentation of lectures and experimental displays in London coffee houses and inns. Their successors, like Benjamin Martin and John Ferguson, took to the road to tour the burgeoning provincial towns.'[2] These developments had followed heated debates in the Royal Society of London in the 1660s and 1670s over just how public scientific knowledge should become. Many individuals with commercial interests objected to the public transmission of processes they used which were being studied by Society members. Yet the Royal Society itself sponsored lectures before carefully selected audiences and began to share its knowledge more widely in correspondence and published transactions during the second half of the seventeenth century.[2] About 1700 is also a period when changing economic and political conditions produced a growing middle class with leisure time and consumer interests. Demonstrations of scientific principles became the subject of popular interest in such forms as: 'illustrated popular books, optical cabinets, marvelous machines, astonishing experiments, and provocative museum displays.'[3] Roving lecturers were especially important agents for the transmission of scientific knowledge outside the cultural and population centres.[4,5]

During the first half of the nineteenth century this pattern repeated itself in the United States.[6] Chemistry lectures seem to have been especially popular.[7] Following Beddoes' and Davy's proof in 1799 that nitrous oxide could be safely respired by humans and produced spectacular behavioural effects, public demonstrations of these effects quickly became common in both Britain and the United States. Davy himself contributed much to the public status of nitrous oxide demonstrations. His experiments with Thomas Beddoes on gases at the Pneumatic Medical Institute in Clifton quickly became the subject of local notoriety.

The discoveries about nitrous oxide attracted a veritable parade of local worthies, including writers and intellectuals, who came to try the gas or watch its effects on others. Among them were Robert Southey, Samuel Taylor Coleridge, Peter Mark Roget, James Watt, his wife and two of his children, novelist Maria Edgeworth, poet Anna Laetitia Barbauld and her husband Rev Rochemont Barbauld, and author and publisher Joseph Cottle.[8] After Davy accepted Count Rumford's invitation and joined the Royal Institution in March, 1801 he continued the gas demonstrations for a brief period. On 20 June, an audience of some 500 people watched such an exhibition and responded with 'unbounded applause'; a more private session the following day was also 'a great sensation'.[9] Reviews of these Royal Institution events appeared in several prominent London magazines of the day.[10] In a published letter, James Stodart described his experience in June 1802, at Davy's Royal Institution exhibitions. 'I have again breathed the nitrous oxide in a very pure state at the Royal Institution, and was as usual lost in pleasure'. Stodart also described his preparation at home of 'six quarts of the gas' to achieve analgesia for 'a pain in the right side of my face and head' which had bothered him for several weeks.[11] Over the next few years the demonstrations at Clifton and London also became the special targets of various satiric attacks by authors and caricaturists who associated the gas experiments - and, indeed, many of the scientific and medical achievements of the period - with quackery and political rebellion.[12]

Davy's influence

The model created by Davy for nitrous oxide exhibitions pretty much set the pattern for the next 50 years. 'Public' demonstrations fell into two main categories - those taking place before a specialized 'public' in chemistry classrooms in medical schools or hospitals, and those exhibited in halls before members of the general public. Knowledge of nitrous oxide was also included in numerous chemistry and medical textbooks published in Britain and America during the first four decades of the nineteenth century.[13] Beddoes' pamphlet published in December 1799, and Davy's great work which appeared in the summer of 1800, are the first such titles.[14,15]

The earliest text in America to describe the Bristol work appears to be the 1802 US edition of James Parkinson's *The Chemical Pocket-Book* published one year after the English edition. In the section on 'Nitrogen' Parkinson notes about nitrous oxide that Davy 'found it to be respirable, producing extraordinary effects on the nervous system'.[16] Prominent New England physicians, James Redman Coxe and James Thacher, published texts in 1806 and 1810 respectively that included material on the Bristol research; Thacher's work includes a lengthy appendix on the topic.[17,18]

Perhaps the most fascinating of all these texts is *Conversations on Chemistry*, an introduction to chemistry for women written by Jane Haldimand Marcet, wife of prominent chemist Alexander Marcet. First published in 1809, the book went through numerous American and British editions and was still in print decades later.[19] Written in the form of conversations between a female teacher and two female students, the work includes a discussion of the effects of breathing nitrous oxide.[20] Subsequent texts and medical dictionaries by Cutbush[21] in 1813, Mitchell[22] and Gorham[23] in 1819, and Hooper[24] in 1824 also included information about nitrous oxide.

Thus two widely divergent views of nitrous oxide were promulgated in the years between 1800 and the mid-1840s. Public demonstrations, such as those by Samuel Colt in the 1830s, and literary satires emphasized the more fantastic or ridiculous effects of inhalation by humans. Even demonstrations in medical school chemistry classes were viewed by students at least as entertainments.[25] Yet chemical and medical textbooks of the period took nitrous oxide seriously, including it among other gases discussed, though often including details of its 'extraordinary effects on the nervous system'.[16] In this mixed atmosphere, one of America's greatest surgeons, John Collins Warren, allowed Horace Wells to come to Boston in January 1845 and demonstrate nitrous oxide for anaesthesia at the Massachusetts General Hospital.

Public demonstrations in Britain

'Public' demonstrations of nitrous oxide inhalation began even before the Bristol trials ended in early 1800. Inventor and industrialist, James Watt, one of the initial participants at Bristol, attended a preparation and inhalation session at a Dr Carmichael's in Birmingham in late November 1799. Watt noted that two men breathed the gas: 'more persons were willing to try but the air holder was exhausted'.[26] William Allen, a young chemistry apprentice, formed the Askesian Society in London in 1796 with a group of friends that included physicians and fellow scientists. At meetings of the Society in January and February 1800, nitrous oxide breathings were held. Allen later became a very popular lecturer in chemistry at Guy's Hospital and his lectures included material on nitrous oxide.[27] These events seem similar to the pattern created at Bristol - what began as private experiments in pursuit of medical advancement quickly became something of a local spectacle, drawing the curious and the repeat breathers. Colton, like so many of the nitrous oxide demonstrators before him, was to adopt the same general model: a serious lecture declaiming the scientific basis, followed by the spectacle of individual behaviour under the influence of the gas.

Historian Joseph Hunter left in his diaries a tantalizing description of a Sheffield lecturer who spoke on nitrous oxide in May 1800, just a few months after the Bristol experiments ended. The Rev Thomas Olivers Warwick, MD, delivered two series of lectures in that city from December 1799 until early 1801, covering a wide range of topics 'for the information of those persons not previously acquainted with Chemistry', according to a local newspaper. Warwick had received his medical degree from the University of Glasgow in 1798. His lectures were apparently 'numerously and respectably attended'. Hunter, whose diary includes entries between April 23 and May 23, 1800, ended his accounts as follows: There is another kind of Nitrous gas called the Deplogisticated Nitrous gas, or Gaseous Oxyd of Azote, which has lately made much noise in the medical world, but the consideration [of] it was deferred to the next lecture.'[28] Whether that lecture included a demonstration is unknown, but the tradition of roving professors declaiming on the subject of nitrous oxide had begun.

Davy's demonstrations at the Royal Institution set the stage for all those to follow in both Britain and the United States. Nitrous oxide demonstrations have been well documented in both countries. Exhibitions by M Henry at London's Adelphi Theatre apparently pleased audiences during its run in May and June 1824. 'The Nitrous Oxide, or Laughing Gas will continue to be administered to any of the Audience who may choose to inhale it' reads one of five surviving handbills for the show.[29] Smith quotes a long description by C F Schoenbein, a German naturalist, who witnessed a gas exhibition at the Adelphi while on a London visit some time before 1839:

> 'When the curtain was raised, you could see on the stage, in a wide semicircle, a dozen or more large caoutchouc bladders with shining metal taps, filled with the laughing gas. The Experimentor appeared in a simple dress suit, and made a short opening speech in which he described the properties of the gas, and its preparation, in a way which would have done credit to a professor of chemistry. At the end of the lecture he asked for someone from the audience to come on the stage and to inhale from one of the bladders. A tall daring fellow jumped over the orchestra and on to the stage, and grabbed one of the bladders.'

The audience shouted disapproval of this young man and the next as well, but then the lecturer interrupted and the show finally continued.[30]

By 1827 William Thomas Brande, ironically in one of a series of lectures at the Royal Institution, criticised a practice popular among students: 'in some of the schools of chemistry I know that it is customary to allow the pupils to breathe it, but it is a foolish experiment.'[31] Such disapproval did not stop the appeal of gas demonstrations for a general audience. In the fall of 1836, William Herapath, a chemist and Bristol native, offered chemistry lectures at the Mechanics' Institution and the Bristol Institution in that city. Several lectures included an 'Exhibition of the Nitrous Oxide Gas', which proved so popular that he repeated them in a second series for a total of six devoted to the gas. Ten years later Herapath was invited to Bristol General Hospital to be the first to administer ether in the city.[32]

Another London venue that hosted gas demonstrations was the Royal Adelaide Gallery. An advertisement from about 1837 declares 'The Laughing Gas every Tuesday, Thursday, and Saturday evenings'.[33] In his 1839 book *Chemistry No Mystery* Scoffern devotes a chapter to a detailed account of a similar event; George Cruickshank's illustration of the resulting chaos serves as the frontispiece to Scoffern's book, which is otherwise a straightforward text.[34] Around 1806, in Glasgow, a Professor Thompson allowed his students to inhale the gas for amusement.[35]

Nitrous oxide demonstrations in America

The earliest classroom demonstrations known to have taken place in America were those conducted by James Woodhouse at the University of Pennsylvania in Philadelphia. Woodhouse, a 1792 graduate of the University's Medical School, had been recommended for the position by Benjamin Rush when Joseph Priestley declined it. By 1802, Woodhouse was Dean of the medical school and in that year he visited London. There he met with Davy, and returned to Philadelphia determined to repeat the nitrous oxide experiments.[36] The first batch of gas he manufactured was 'extremely impure' so he substituted 'atmospheric air' and let his students breathe it under the impression they were inhaling nitrous oxide. The resulting effects they reported led Woodhouse to believe: 'that the influence of the imagination, caused all the effects ascribed to the nitrous oxide'. Yet, in the winter of 1806, he tried again. He manufactured 'a quantity of this gas, extremely pure' and let eleven students inhale it. The resulting behaviour forced Woodhouse to revise his opinion: 'I am now perfectly convinced, the gas produces all the effects subscribed to it by the justly celebrated Mr Humphrey [sic] Davy ... and I am happy in having this opportunity of confirming his experiments'.[37] Nine additional students tried the gas a week later. One student in the first group, William P C Barton, wrote his medical school dissertation as a defence of Davy's work and an effort to bring together research on nitrous oxide 'diffused in light and fugitive publications that are difficult to access'[38] Barton went on to a long career in American naval medicine, about which he wrote several works.[39] Although he lived until 1856, Barton apparently had nothing more to say in print on nitrous oxide or indeed about anaesthesia.

Classroom demonstrations also took place with some frequency in the 1830s at Fairfield Medical College in New York. A letter discovered in 1933 notes that: 'Preparations are making to administer the protoxide of nitrogen gas tomorrow. A goodly number of students intend to take it and we expect some sport as usual'.[40] One has to wonder if classroom demonstrations often mutated into nitrous oxide parties.

Demonstrations of the gas for the general public also began quickly. John Griscom offered such a lecture series in New York City in the winter of 1807-08. He issued a 'printed prospectus of a course of lectures in chemistry' in the autumn and sold about 100 tickets at $12 each. Griscom had attended lectures by Woodhouse in Philadelphia; Woodhouse had given him a 'small book of his own, describing numerous experiments, and I immediately went to work with such simple articles as I could obtain'. Griscom convinced 30 friends to contribute $50 each to purchase apparatus from William Allen in London. Allen also sent copies of Henry's *Chemistry*, Marcet''s *Conversations on Chemistry*, and Accum's *Chemistry* - all reputable texts of the time.[41] Griscom's lecture course was very popular: 'His lectures have been attended by upwards of one hundred persons of both sexes, and have obtained a very distinguished degree of approbation. In the course of his experiments, he made many trials of the peculiar effects of *nitrous oxide*.' Details of some of these trials were published in the *Medical Repository*.[42]

In 1813, while a senior at Harvard, James Freeman Dana obtained his chemistry professor's permission to use his lecture room to give a public lecture and demonstration on nitrous oxide. Dana, who soon became Professor of Chemistry at the State University of New York, was a 'luminous impressive, and successful lecturer ... As an experimenter he was unrivalled'.[43] He died in 1827 at the age of 33.

In early 1813 Philadelphia hosted a pair of lecturers who demonstrated nitrous oxide. James Cutbush, whose *Philosophy of Experimental Chemistry* appeared that year and included several pages on nitrous oxide, advertised a series of lectures in February to include '...at the request of several Ladies, the Nitrous Oxid [sic], or the *Exhilarating Gas....*'. These lectures were held in the newly-constructed St. Johns Lyceum building at the corner of Chester and Race.[44] The previous month Thomas P Jones advertised a nitrous oxide lecture at his "Chemical Lecture Room" at the southwest corner of Fourth and Chestnut Streets. 'A large quantity will be prepared,' he noted, and the nitrous exhibition would be 'accompanied with a number of experiments.' Tickets, which sold for 50 cents, were to be had 'at A. Finley's Bookstore' or at the lecture hall the night of the show.[45]

A pamphlet published in 1814, and written in the first person, gives a vivid portrait of a public demonstration in Philadelphia. After a scientific introduction on the nature of nitrous oxide, the author tells us that he noticed in a local paper that: 'Dr Jones's weekly lecture upon this interesting subject was advertised for the last time this season. I immediately called for my hat and cane, and sallied forth to procure a ticket.' He then gives a lengthy description of events in the lecture hall at Harmony Court. The 'doctor' lectures 'at sufficient length, upon the nature and properties of nitrous oxide' and performs a series of minor experiments, 'to which very little attention is paid by his audience.' Then 10 or 12 young men are invited on stage to breathe the gas. The men react with violent actions and speeches, a state of intoxication the author compared to the political state of the nation at that time.[46] A recent writer believes that to the pamphlet's author this behavior personified 'the volatility of the democratic masses' as peace negotiations were about to get underway with Britain to end the War of 1812.[47] The pamphlet's tone makes it difficult to determine if an actual event is being described or a proceeding with which the author was familiar was used inventively to make his larger point. A search of Philadelphia newspapers of the period might establish whether or not a 'Dr Jones' ever lectured there on nitrous oxide.

In 1818, Thomas Cooper, a chemistry professor at the University of Pennsylvania, mentions the 'medicinal exhibition of gases', including nitrous oxide: 'Physicians found that it required too much trouble and too much skill to exhibit the gases; and they have been cried down.'[48] Cooper defends the use and potential of gases; his observation about the difficulty may refer to the use of gases in patient care. Yet the widespread demonstrations in classrooms and before the public show that by 1818 gas manufacture and use was relatively easy.

Before coming to Colton, two other exhibitors are worth mentioning. During a public demonstration of the gas by Stockton in New York City on 6 November 1819, a child in an adjacent room breathed some gas from an open container, and was later found unconscious by Stockton.[49] In 1821 a Dr Preston gave exhibitions at the City Hotel in New York City and protested that 'some persons, who have no pretentions to chemistry, have advertized such exhibitions'.[50]

Colt and Colton

Samuel Colt is one of the American nitrous showman who preceded Colton about whom we know something more. Born in Hartford, Connecticut, in 1814, Colt left home and took to sea in 1830. There he supposedly conceived and carved a revolver pistol. He commissioned his first prototype in 1831 and spent the next three years trying to find gunsmiths who could create his design. During this period Colt spent two years attempting to raise money as a nitrous oxide showman. Colt styled himself: 'Dr S Coult', a practical chemist from New York, London and Calcutta' on the advertisement that has survived from a Portland, Maine, exhibition in October 1832. Colt credits Davy in the advertisment, and further notes: 'Dr C has exhibited the extraordinary powers of the gas in many cities of the United States, to audiences composed of Ladies and Gentlemen of the first respectability - and many Ladies have inhaled the gas at select Exhibitions'.[51] Tickets were fifty cents and available at Appleton's Hotel, G Hyde's Bookstore and Coleman, Holden and Co, as well as at the door the evening of the demonstration. One account published in 1857 claims that Colt 'went into every state, and into every town almost of two thousand inhabitants in the country'.[52] Colt seems to have outdone even Colton in the extent of his US touring.

All these documented examples of classroom and general public exhibitions of the gas are probably just a fraction of those which actually took place. Further research in newspapers and other sources should uncover more information about these examples, new examples, and further details about the touring career of Colton himself.

Although Colton has not been the subject of the full-length biography he deserves, the facts of his life are well-known.[53] He was born in Georgia, a small town in Vermont on Lake Champlain, in February 1814. After jobs on a farm and as a chairmaker, Colton entered Crosby Street College of Physicians and Surgeons in New York in 1842 when he was 28 years old. After two years in medical school, Colton decided to 'throw physic to the dogs', left without a degree and began to lecture on chemistry topics. Colton had tried such a lecture, including a nitrous oxide demonstration, at a ladies' seminary while a medical student. Fellow students asked him to prepare gas for them and one suggested he rent a hall and give a public demonstration. Colton liked that idea, and on 6 April 1844, he put on a show for over 3,000 people at the Broadway Tabernacle. A reprint of a long contemporary newspaper account of this event can be found in Smith's *Under the Influence*.[54] Colton then began a New England tour that would include the famous exhibition in Hartford, Connecticut, on 10 December, attended by Horace Wells.

In his novel *The Sleep of Life*, Richard Gordon (pseudonym of British anaesthetist Gordon Ostlere) depicts events surrounding the discovery of anaesthesia as seen through the eyes of a young journalist, Guy Romilly. His American correspondent, Miss Charlotte Conybeare, describes in a letter Colton's Hartford gas demonstration as outlined to her by Sam Cooley:

> 'The lecture in the Union Hall that night was given by Professor Quincy Colton. I'd better explain that he wasn't really a professor at all. People out here often call themselves 'professor' if they want to impress folk in some way. 'Professor' Colton arrived in town to give his lecture on electricity and laughing gas, which he advertises all round New England and says he has delivered at the Broadway Tabernacle in New York before an audience of a thousand people. All Hartford society attended, even at twenty-five cents a ticket. Dr Wells the dentist was there, with Mrs Wells. Sam knew them well from the store, where they purchased oil of cloves and suchlike.... The laughing gas was in a rubber bag, which the 'professor' carried round the rows of seats calling for volunteers---among gentlemen only, and of the *first respectability*. Sam says he didn't inhale that night. Perhaps he wasn't sure of being respectable enough. Or he was scared of making an exhibition of himself. Under the gas, you are supposed to act out your leading trait of character, to sing, laugh, dance, orate---or fight! There were special strong men put in the front row to restrain folk who did. But it seems no one performed these antics. Perhaps such aren't among the leading traits of anybody's character in Hartford.'[55]

Gordon's account is fictionaliszed only a little. Perhaps Sam Cooley did breathe the gas and didn't want to admit that to Miss Charlotte. Colton's own account of the event of course does note that 'a young man by the name of Cooley' did participate and bruised 'his legs badly'.[56] Horace Wells then made the connection between gas inhalation and Cooley's inattention to his injuries. Gordon's version includes many elements of real nitrous oxide exhibitions: the travelling 'professor' who carefully notes his past successes, the large crowds despite the relatively high cost of a ticket, limitation of participants to men and only those of the highest respectability, the expectation of character revelation under the influence of the gas, and 'strong men' to provide security. Grayson contends that these trappings allowed nitrous oxide exhibitions to become one of the '1840s new forms of commercial spectacle [that] furnished the means to preserve codes of conduct and delineate the parameters of middle-class respectability with greater effectiveness than abstinence from the theater or horseracing could ever have hoped to accomplish'.[57]

In his history of nitrous oxide anaesthesia Smith makes a comparison of the advertisements used by Colt and Colton, noting that Colton's 'bears a striking resemblance to the bill which advertised Samuel Colt's ....demonstration in Portland twelve years before'.[58] Colt's mentioned Davy, while Colton's has a quote from Robert Southey, who was among the Bristol experimentors, and cites a medical dictionary that mentions Davy in its entry on nitrous oxide. An undated handbill titled '*Exhilarating Gas*', now in the Reynolds Historical Library in Birmingham, Alabama, also has some characteristics in common with the advertisements of Colt and Colton. This handbill mentions Southey and his reaction to the gas and further assures readers considering attendance that: 'A number of very respectable young Gentlemen have already volunteered to inhale the Gas'.[59] Tickets sold for 50 cents instead of the 25 cents charged by Colt and Colton. This mystery handbill mentions several specific place names: Bank Coffee-House, Tammany-Hall, Washington-Hall and printer Bell and Scott on Pearl Street. Tammany-Hall and Pearl Street seem to indicate New York City, but the other places and the printer have not been located there. My attempts to identifiy the city and approximate date have so far failed, and this handbill advertisement remains a tantalizing mystery.

Colton continued his tours until some time in 1848 or 1849, expanding to cities in the Midwest such as Pittsburgh, Cincinnati, Louisville and St Louis, and southern cities such as New Orleans and Mobile, which is where we meet him. In 1849, his brother Walter received an appointment as Civil Governor of California, and Colton quickly joined him. Colton was appointed the first Justice of the Peace in San Francisco in the late fall, but was soon involved in a controversy over some town lot grants and he returned to the East.[60] For a number of years he tried various jobs including journalism and investments. Having lost his money in the latter, he returned to nitrous oxide lectures and exhibitions.

Exhibitions in Mobile

Colton arrived in Mobile, Alabama, in early March 1848. Mobile is located in the extreme southern part of Alabama and is the State's only seaport on the Gulf of Mexico. After a chequered history involving ownership by Spain, France and Britain, Mobile finally became part of the United States during the War of 1812, and began to prosper from the extensive cotton trade. By 1840 more than 12,000 people lived in the town; one-fourth were slaves. A Northern visitor in 1844 noted 'the great varieties of character in the streets of Mobile ... staid thinking men and brainless fops'. Mobile's elite society constructed a world of huge mansions, social clubs, balls, parties, parades, horse racing, gaming houses and the theatre. Many of the city's male residents of all classes entertained themselves in the plentiful saloons and brothels.[61] Into this society in the late winter of 1848 came Gardner Quincy Colton, fresh from a successful stand in the South's even greater cosmopolitan seaport, New Orleans.

Colton had some competition for the exhibition audience that winter. On Monday 7 February, the Mobile *Register and Journal* announced that: 'A lecture on Phrenology and Mesmerism with an exhibition of Clairvoyance, will be given at the Alhambra, this evening, by Mrs Loomis and her family'.[63] Reports from neighbouring cities 'have given very favourable accounts' of the phrenological display, the paper's anonymous author noted, and also praised the clairvoyance demonstration, of which 'we can say something, having seen and aided in trying experiments, under circumstances extremely favorable to calm conclusions'.[63] Two days later the paper published a lengthy piece about the Mobile appearance of the Loomis family: 'Of late years we have heard so little of the above sciences [mesmerism and phrenology], that we had almost arrived at the conclusion that they had become obsolete, but the experiments performed by Mrs Loomis, with her children on Monday night, before a large and fashionable audience in this city, persuades us that we were mistaken.[64] Mrs Loomis offered 'quite an interesting lecture on the two subjects' and then proceeded to the clairvoyance experiments with her daughter Martha and 'phreno-magnetism' demonstrations with another daughter and a son. The paper noted Mrs. Loomis appeared on Tuesday night 'before a still more numerous audience' and would conclude her visit with final performances that evening, Wednesday.

Mrs Loomis' 'phreno-magnetism' was a combination of phrenology and mesmerism that flourished briefly during the 1840s and 1850s. Many phrenologists were appalled at this wedding of their science and the 'show business' of mesmerism.[64] Englishman, Robert H Collyer claimed to have founded this hybrid science, just as a few years later he would claim to have discovered anaesthesia.[65] Collyer, another travelling showman, also followed Colton to Mobile; his visit is noted below. Thus Mobile at this moment, with the visits of Mrs Loomis, Colton, and Collyer in quick succession in 1848, served as a microcosm of the rich stew of 'sciences' sweeping through the Western world during the first half of the nineteenth century: mesmerism, phrenology, spiritualism, and so forth.[66-72] Travelling lecturers like Mrs Loomis and Colton combined these topics or added things like telegraph demonstrations to appeal to wider audiences and legitimize their appearances. These shows usually included opening lectures to explain the scientific principles involved to the audience, which was always large but composed of the respectable and fashionable citizens of the community. Interestingly, figures like Reubens Peale, museum administrator and brother of painter Rembrandt Peale, and Edgar Allan Poe, took serious interest in mesmerism, which despite some success as an anaesthetic technique, was ridiculed by most of the medical profession and lost its use in surgery after the discovery of ether's anesthetic properties.[73-76] Yet all of these 'sciences' developed enthusiastic supporters, societies, journals, books, schools and schisms without end.

Colton in Mobile

Colton's first Mobile lecture and exhibition took place on Friday evening, 10 March, at the Franklin Hall on St Joseph Street. The previous day's newspaper alerted readers about the coming show:

> 'Dr.Colton's Lectures.
>
> This gentleman will commence a course of scientific lectures to-morrow [sic] evening at the Franklin Hall... The First will be upon the Telegraph, accompanied with a practical exhibition of its operation. A telegraphic line will be erected in the Hall, with battery, wires, and register, to represent Mobile and New York... A gentleman from the telegraph office in this city will occupy one station and Dr.Colton the other, when letters will be passed between them by electricity... Dr.C. comes among us with high recommendations from Professor Morse and other distinguished gentlemen, and the unbounded success which has attended him in other cities is ample proof of the satisfaction which his lectures afford.'

Actually, Colton connected his wire to the one which ran outside the Hall and communicated with the local telegraph office in that way.[77]

A part of Colton's travelling multi-media extravaganza had already arrived in Mobile a week earlier. On 3 March, Rembrandt Peale's painting *The Court of Death* went on display in Franklin Hall. Colton made the exhibition of this giant work a regular part of his tours. The painting was to remain on exhibit for six evenings from 7 until 9:30 p.m; the entrance fee was

50 cents or $1 for all six exhibitions. Despite this 'six nights only' advertising, Colton offered free showings of *The Court of Death* after some of his performances: 'This is the original Painting by Peale, and is valued at *twenty-five thousand dollars*' one of his advertisements read.[78] The Mobile newspaper declared: 'As a work of art, this [painting] is probably the best ever exhibited in this city.'[77] The paper claimed on 15 March: 'Many inquiries have been made since the close of the exhibition of this painting whether it would not again be opened before leaving the city. We have now the pleasure to state that Dr Colton has concluded to give a free exhibition of it, at the close of his next lecture... This painting, a truly a [sic] most sublime and magnificent work of art, which not a single citizen of Mobile, lady or gentlemen, should fail to see.'[79]

Peale's *The Court of Death* is a huge work measuring 13 feet high and 24 feet long; it is currently owned by the Detroit Institute of Arts. Described by one authority as Peale's 'most popular and important painting ...the *Court of Death* was in the reform mode, designed to dramatize the separate evils that the individual should avoid to achieve a rational and happy life and escape the terrors of death.'[80] Peale completed the painting in 1820 in an effort to emulate several other huge works that had successfully toured the country and lift himself out of debt. Peale was the son of Charles Wilson Peale (1741-1827), one of the new nation's best known painters, who was instrumental in founding the Philadelphia Museum and the Philadelphia Academy of Fine Arts. Rembrandt, under his father's tutelage, quickly became an accomplished artist. He worked hard at it, even attending James Woodhouse's chemistry classes at the University of Pennsylvania 'in order to gain knowledge of the chemistry of paint'. Through his father's influence, George Washington sat for the young painter in 1795. By the age of thirty Rembrandt had made artistic pilgrimages to London and Paris. During his career Peale did portraits of two great men with anaesthesia history connections - Joseph Priestley and Samuel Latham Mitchill. After several unsuccessful ventures, Rembrandt sent his large moral painting, *The Court of Death*, out into the country on exhibit, but touring expenses reduced the anticipated profit despite lively ticket sales and sympathetic sermons from local ministers.[81] Peale then abandoned museum and commercial management and concentrated on his art; he died in 1860. How Colton became associated with Peale's *The Court of Death* is unknown, but its presence in his exhibitions allowed him to envelop his laughing gas demonstrations in great moral dignity - just as the presence of the telegraph exhibitions provided a practical scientific and technological accompaniment.

Colton and Morse

On his exhibitions of the telegraph, in the mid-1840s Colton claimed:

> 'Professor Samuel Morse took me into his office and gave me full instructions in regard to the construction and operation of his magnetic telegraph, and afterward allowed me to announce a lecture on the telegraph under his 'auspices', in the Broadway Tabernacle ... Professor Morse said I made one or two slight mistakes in my lecture, but on the whole he was so well pleased with it that he gave me ... a letter of unqualified recommendation to the public as being able to explain his telegraph. With this letter I travelled and lectured all over the United States.'[82]

Smith and Hirsch note that Colton 'was involved in the first telegraph message ever to be received in New York'.[53] I have searched Morse's collected letters and several biographies and found no mention of Colton. However, Morse, who had received a telegraph patent in 1840, no doubt allied himself with numerous individuals who were willing to promote his invention.

Samuel F B Morse (1791-1872) had developed his idea for a telegraph while sailing aboard the *Sully* from France to New York in October 1832. Also aboard was a second anaesthesia history figure to cross paths with the telegraph, Dr Charles T Jackson. According to an 1846 account, a ship's mate named Blithen, who had served on the *Sully*, recalled several conversations between Jackson and Morse in which Jackson 'made the suggestion of the possibility of an electric telegraph'. Blithen noted that despite Morse's questions to Jackson, the whole matter was 'entirely outside of the profession of painter to which he belonged'.[83] By the early 1830s Morse had indeed become a well-known American artist, a career remembered by only a few specialists today.[84,85] Jackson's later claim to some credit for the telegraph's development was disputed at the time and now largely forgotten, although a recent history of the invention gives this story some credence.[86,87]

Colton's demonstrations and lectures

Although Colton's shows in Mobile began in Franklin Hall, they seem to have quickly moved to the Alhambra Hall on 52 Dauphin Avenue at the corner of South Royal Street very near the waterfront on Mobile Bay. An advertisement from the 1859 *Mobile City Directory* emphasizes the Hall's 'restaurat [sic], Coffee-Saloon, Oyster-Stand and Bar Room'.[88] A description of the building written by a Works Project Administrator in the 1930s notes that it 'was about 100 feet long and 40 feet wide, and the second floor, intended for an Assemby [sic] room, was one of the largest in the South, and had a spring floor... It was a theatre at one time and also a favorite location for Mobile Physicians'.[89] Presumably Colton shifted his exhibitions to the larger hall as audiences began to grow.

Colton heavily advertised his programmes, but the content of the newspaper advertisements changed during the course of his visit. A promotion of *The Court of Death* ran in the 8 March issue. Ads on March 11 and 13 announced his 'Telegraph Exhibition', which expanded to 'Telegraph and Court of Death' for March 15, 16, 17, and 18 issues. On March 22 the notices began a transition: 'Natural Philosophy and the Court of Death' read the headline of that one. Finally, Colton announced just 'Laughing Gas' in his notices of March 21, 29, 30, 31 and April 5. In a typical issue Colton's advertisements might compete with others announcing 'Connell's Magical Pain Extractor', Dr Christie's Medical Galvanism', 'Dr Sphon's Sick Headache Remedy', and 'Juno Cordial or Procreative Elixir', all of which appear to be non-local products.[90]

Of additional interest is an April 5 advertisement by S B North, 'Surgeon Dentist', who noted: 'Chloroform... This chemical preparation has satisfactory [sic] proven itself in several surgical operations in Mobile... At the solicitation of many friends, I offer my services in the extracting of teeth by putting the patient under the influence of this pleasant and effective anesthetic agent.' 'R North and Co, Chemists' (presumably a brother) also advertised that they manufactured and sold chloroform and advised: 'We have the liberty of referring to Dr Lewis, Surgeon of the Marine Hospital', in regard to chloroform.[91]

The Mobile newspaper reacted positively to Colton's first appearance: 'The Lecture and Exhibition by Dr Colton last evening, was all that his high reputation had led us to expect, and we were pleased to see an audience in attendance composed of the best minds in the city. Dr C. may rest assured that so long as he can give an entertainment equal to that of last evening, his hall will be crowded.'[92] On March 22, the paper's anonymous author (probably its editor) observed: 'The Alhambra has been crowded for a few evenings past by thinking and intelligent people, who have hastened to Dr Colton with no little satisfaction. The Doctor is peculiar in his style of lecturing. He makes no attempt at display... he presents [his subjects] in plain language.' The paper then praised Colton for 'placing the admission low'.[93]

Exactly what Colton demonstrated and lectured about besides the telegraph and laughing gas and the meaning of *The Court of Death* is somewhat unclear. Both Colton's paid advertisements and the newspaper's articles refer to a variety of presentations without being very specific. By 1 April an article declared that Colton 'will combine all his principle experiments in one evening'.[94] One notice on 17 March states that: 'In compliance with many requests, Dr C. will ... exhibit and set in operation the *Electric Rail*, which was received with so much applause a few evenings since'.[95] Here, Colton was exhibiting his own invention: 'one of the first motors in electric railroad history'.[53] Another notice mentions 'the Magic Slippers and an experiment in galvanism upon a rat'.[96] I have not yet determined what is meant by the 'Magic Slippers' but a later article declares they 'alone are worth the admission to those who love a hearty laugh'.[97]

Unfortunately, few details of the Mobile laughing gas demonstrations appear in the paper's articles. The most detail is given in Colton's advertisement:

> 'Forty gallons of Gas will be prepared, so that a large number may inhale it. Six Gentlemen have volunteered to inhale the Gas to commence the performances - Dr Colton will be the first. Twelve Strong Men will stand upon the stage, to prevent those who inhale the Gas from injuring themselves or others while under its influence. The Gas will be administered only to gentlemen of the first respectability. Dr C would say to his friends, the ladies, that he has given hundreds of similar exhibitions and nothing has ever occurred to offend the most fastidious... The whole will be conducted upon scientific principles.'[98]

This advertisement emphasises Colton's long experience with the gas. How much nitrous oxide did he inhale over the years giving these exhibitions? Or at some point did he begin pretending to inhale and merely imitate various laughing gas-induced behaviours? His public relations skills are obvious. The protection by twelve strong men might invoke a religious connotation in many members of the audience and he guarantees that nothing will happen to offend even the most delicate female sensibility.

The newspaper devoted more space to describing the shows of Mrs Loomis and her family than to Colton's laughing gas exhibitions. Should we conclude that the readers already had knowledge of what happened at such shows and there was no need to give much detail? The editor did make sure readers understood that the laughing gas demonstrations were as respectable as other portions of Colton's show: 'Dr Colton has taken great pains in getting it [laughing gas exhibitions] up, that it may receive the patronage of the same class of ladies and gentlemen that have attended his former exhibitions'.[99] Other articles in late March and early April note that Colton had been 'induced to give one of his grand exhibitions... of laughing gas effects', and a reference is made in one article to his 'private entertainments' with the gas.[94, 100,101] Several references also appear to special laughing gas demonstrations limited to women.[94]

By the second week of April Colton had departed from Mobile, his immediate destination unknown. Three days later Robert H Collyer brought his 'Model Artistes' show to town. This exhibition consisted of live actors recreating paintings and sculptures by such artists as Titian, Raphael, and Rubens.[102] Collyer was an Englishman who in the 1830s had studied mesmerism under Elliotson, phrenology under Spurzheim, and whose life story is as fascinating as Colton's.[65] He published extensively on phrenology and other topics and toured widely; he conducted mesmerism experiments in 1841 at the New York museum operated by Rubens Peale, Rembrandt's brother.[103 -106] Collyer was also a minor claimant in the battle over who discovered anesthesia.[107] The day before arriving in Mobile, Collyer ran a notice condemning companies of 'vile imitators' that were also touring the county. Collyer also declared the purity of his show, which contained nothing that 'would produce a blush on the most virtuous cheek'.[108]

Conclusion

Colton's appearances seem to have been carefully constructed combinations of moral instruction (*The Court of Death*), scientific and technological lectures and exhibits (telegraph, electric rail, nitrous oxide) and more lighthearted or potentially-but-never-quite naughty demonstrations (Magic Slippers, laughing gas breathing). At each stop Colton, through advertising, newspaper accounts, word-of-mouth and his actual appearances, took his audiences through these steps, reaching a crescendo with the laughing gas sessions. Thus Colton built a 'message of spiritual redemption and economic progress' that would appeal to all classes, but especially the growing middle class and their political and religious leaders.[47] His programmes were entertainments that would instruct, inform and tease. They would fill his audiences with a sense that great technological marvels were abroad in the land and yet give a glimpse of psychological unknowns in human behaviour in a controlled environment. 'Dr' Colton was a consummate showman, skilled in the art of audience manipulation. But he also really knew his stuff and went on to contribute more to anaesthetic progress. By late 1863 he had allied himself with two prominent New York City dentists and founded the Colton Dental Association 'because my name had so long been identified with the gas'.[110] Between 1864 and 1897 almost 194,000 nitrous oxide anaesthetics were administered under the auspices of the Association. Colton toured Europe and the U.S. promoting this work until his death in Geneva, Switzerland, on 10 August 1898, fifty years after leaving Mobile, Alabama.

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THE PROFESSIONS OF DAVY'S NITROUS OXIDE SUBJECTS

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More than sixty individuals took part in Davy's experiments with the human respiration of nitrous oxide, whether as experimenters, patients, healthy volunteers, or witnesses. Of these about a third were anonymous, because they were patients or because they were women whose reactions were labelled 'hysterical'. Another third were named and had their experience briefly summarised. The remainder made signed statements of their own experience. Who were the named participants? The information is essential if we are to ask wider questions about Davy's experimental design, the effect of professional interests on his descriptions, the social preconditions for his brilliant enquiries, and even the limits on the dissemination of his insights.

The evidence in Humphry Davy's *Researches .... Concerning Nitrous Oxide* (London, 1800) overlaps with that in Thomas Beddoes' *Notice of Some Observations made at the Medical Pneumatic Institute* (Bristol, 1799). A difficulty that has confused several biographers is that both of them recorded many individuals only by surname plus title or initials: J W Tobin was not the minor playwright John Tobin who had left Bristol in 1787, but his brother, Davy's assistant, James Webbe Tobin; Josiah Wedgwood cannot have been the great potter who had died in 1795, but was his son of the same name; Joseph Priestley was not the famous chemist then exiled in America, but his son and namesake. Otherwise, it is not hard to identify most of those listed with known members of the social circle around Beddoes, Davy and the two young poets, Coleridge and Southey. The fit is too good, for too many names, for this to be a matter of chance. Moreover, since carrying out the exercise for myself I have come across A J Wright's identifications,[1] and our few disagreements do not affect the main picture. My purpose in this note is to identify most of the named subjects by profession.

Doctors

The first of the doctor subjects was Beddoes himself, who was also regarded at the time as a chemist.[2] Nitrous oxide made his wife feel that she was 'ascending like a balloon'. Mrs Beddoes was Anna Edgeworth, younger sister of the novelist Maria Edgeworth and daughter of the inventor and educationalist Richard Edgeworth - a leading member of the predominantly scientific society known as The Lunar Society of Birmingham.[3] Richard's son, Lovell Edgeworth, also took the gas, as did three other sons of Lunar Society members - Joseph Priestley, James Watt and Josiah Wedgwood - who had been sent to Beddoes in the hope that he might cure their consumption. Davy described Anna Edgeworth as 'the reverse of Dr Beddoes - extremely cheerful, gay and witty'. It was largely due to her that so many 'congenial souls' gathered in the Beddoes drawing room, where John Davy tells us his brother made friends with 'men of genius ... and though the great objects of his pursuit were of a scientific nature, yet he found time to take a part with them in labours purely literary'.

Other doctors besides Beddoes were directly involved in the work of the Pneumatic Institution and naturally took part in Davy's experiments. Dr Robert Kinglake helped Davy observe the effects of suffocating animals in nitrous oxide. Peter Mark Roget, whose first medical paper[4] had just been published by Beddoes, was now employed by him as a physician. The Preface to his *Thesaurus of English Words and Phrases* (1852) says his first such 'catalogue of words' was completed in 1805. It may be significant that this massive work began so soon after the novel experience of nitrous oxide posed such a challenge to the vocabulary of its first explorers. Stephen Hammick was a Plymouth surgeon whose paper 'On the Treatment of Syphilis by Nitrous Acid' had appeared in Beddoes' *Contributions to Physical and Medical Knowledge, principally from the West of England* (1799). I know nothing about two other doctors amongst the subjects: Drs Kinglake and Wilmot. Matthew Coates had medical connections at least, being the brother-in-law of the medical writer Joseph Adams. His family had also figured in the story of the boy who struck light from bonnet-canes,[5] a celebrated example of how Davy could seize an observation and rapidly investigate and generalise it.

Chemists

After medicine, the best-represented discipline was chemistry. Joseph Cottle remembered the zeal with which Davy 'wished to induce as many as he could to pursue his favourite chemistry'. Under this heading could be included several young men who made observations and experiments, including Lovell Edgeworth and James Webbe Tobin. Joseph Priestley junior, on a visit from America, makes two appearances in Davy's book. His unpleasant experience under the gas is noted in one sentence. More interesting is the pride with which Davy records a chemical experiment 'performed with the assistance of my friend, Mr. JOSEPH PRIESTLEY, Dr. PRIESTLEY's eldest son, and chiefly detailed by him in the journal'. Similarly, James Thomson occurs both as a nitrous oxide subject and as a fellow chemist debating the theory of the difference between nitric and nitrous acid.

Two more chemist subjects were William Russell Notcutt and William Clayfield. Notcutt, 'formerly lecturer on chemistry at Hackney', had figured in *Nicholson's Journal* in a dispute over priority in the discovery of strontium deposits near Bristol. William Clayfield had published in *Nicholson's Journal* and adapted Watts' mercurial airholder for Davy's use.[6] His father, Michael Clayfield, had been the benefactor of the famous Bristol poet, forger and suicide, Thomas Chatterton. What gives particular interest to the participation of Notcutt and Clayfield is that they had recently been involved in the trial of a quack cure, 'Perkins's Metallic Tractors'. They had witnessed John Smith's experiments on the tractors at the Bristol Infirmary.[7] I would argue that it was the exposure of Perkins' tractors in this trial that spurred Davy into more rigorous design for his nitrous oxide experiments - in particular, the use of atmospheric air as a control.

Engineers and manufacturers

James Watt is famous, and his collaboration with Beddoes well documented.[8] He had written with Beddoes about synthetic gases, and designed an inhalation mask and a calibrated air-holder. His son Gregory, a tubercular patient of Dr Beddoes, had lodged with the Davy family in Cornwall and was thereby one of the connections through which Davy was appointed at the Pneumatic Institution. Watts and his son inhaled nitrous oxide, as did Matthew Robinson Boulton, the son of Watt's manufacturing partner.

Other subjects associated with manufacturing were three sons of Josiah Wedgwood the potter.[9] Thomas was Beddoes' patient and, with Josiah junior, the benefactor of both the

Pneumatic Institution and Coleridge. As a pioneer photographer,[10] he counts as a chemist. Wright lists Thomas and Josiah junior; Beddoes however has not only both of these but also an entry for another 'Mr. Wedgwood' whose details are the same as the 'Mr. Wedgwood' whose experience with the gas is given by Davy. I propose the eldest brother John, who as the senior member of the family, might have been distinguished by title rather than first name.

Another manufacturer subject may have been the tanner, philanthropist and friend of Coleridge, Tom Poole - if, that is, Wright is correct in interpreting 'Thomas Pople' as a misprint. On the one hand, both Beddoes and Davy have 'Pople' and that is a valid surname: indeed, a few years later, Southey's printer was a W Pople. On the other hand we know, from a letter of Tom Poole's to Davy's early biographer Dr John Paris, that Poole did inhale nitrous oxide 'with the usual extraordinary and transitory sensations'.[11]

Civil servants and politicians

John Rickman, a close friend of Southey's, was a House of Commons official who was responsible for such government reports as the annual abstracts of poor-law returns. He was to prepare the first national census in 1800. Davy gives summary accounts of the nitrous oxide experiences of two politicians. 'Mr Wynne, MP' must, despite the spelling, have been Charles Watkin Williams Wynn, the friend and benefactor of Southey.[12] Others of the family spelled their names 'Wynne'. 'Mr Mackintosh' was probably the later knighted James Mackintosh, political philosopher and politician.

Poets and writers

It is needless to identify a Mr Coleridge, whose report of the gas (Davy taking it alongside him!) Beddoes rushed into a postscript; but we may have to remind ourselves that Robert Southey was Poet Laureate from 1813 to 1843. As well as several books of his own, Southey had published poems by Davy in his *Annual Anthology*. Beddoes also wrote verse,[13] as did another subject, Anna Laetitia Aikin (known as Mrs. Barbauld), already famous for her *Hymns in Prose for Children* (1781). With her husband, the subject Rev Rochemont Barbauld, she was involved in London circles of political and religious dissent (there was also a Rev WA Cane amongst the subjects). Other writer subjects were the antiquary Henry Wansey, and George Burnett who tried various jobs, including army surgeon.[14] When the *Anti-Jacobin* satirised Beddoes,[15] it included the poet George Dyer amongst 'The Pneumatic Revellers', but there is no real evidence of his participation. Finally, all records of clinical trials should mention refusers: the publisher and minor poet Joseph Cottle tells us in his *Reminiscences* that he did not inhale.

It will be seen that Davy's subjects were recruited not as a random population but from a definite social group, representing the very people he hoped to convince. I would be very grateful for corrections, or any information on the following nitrous oxide subjects: Dr Blake, Rev WA Cane, Mr H Cardwell, Michael Castle,[16] John Cave junior, Matthew M Coates, Patrick Dwyer, Mr Jarman, Miss Morgan,[17] Miss Ryland,[18] Dr Wilmot - and anyone called Pople!

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18. Southey knew a Mr Ryland at the Baptist Library.

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BEDDOES' PATRONS

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Bristol owes its association with Humphry Davy to Thomas Beddoes. It was he who brought Davy to Bristol.

Beddoes came from Shifnal in Shropshire where, some years later, Henry Hill Hickman had his practice. Hickman's struggle to obtain influential patrons is well known. Beddoes had an additional problem when seeking such support: he held extreme political opinions. He had openly advocated revolutionary changes in society, had attacked the government, his university and the Royal Society. He had chosen as his publisher Joseph Johnson, who was sent to prison for sedition. With this background he could not expect the leaders of the established order of society to rush to offer him their patronage.

I was interested in what sort of people would allow their names to be associated with his, and their money to be used by him. Beddoes' patrons came from a wide variety of backgrounds. They included members of the nobility, politicians, the medical profession, scientists and manufacturers.

The Duchess

The most noble, the most famous, and the most beautiful of his patrons was Georgiana Spencer, daughter of the first Earl Spencer. She married the Duke of Devonshire, one of the wealthiest and most powerful men in the country, when she was just seventeen. The young Duchess immediately became the leader of London's high society, presiding over the most influential salon of her time, the 'Devonshire Circle'. She was adored by the Prince Regent, became a close friend of the Whig politician, Charles James Fox, and was deeply involved in the politics of the period.

She became a patron of young scientists, including Thomas Beddoes. In a letter to her brother about Beddoes, she wrote:

> 'It is these three years I have known him, and followed his discoveries in pneumatical chemistry and his application of them to health. His proposals are very fair and candid, and he is full of genius and good sense in everything but the one subject of politics, in which he has neither judgement, taste or temper.'

Despite his politics, she gave him financial support. She also encouraged him to proceed with the more ambitious plan of founding a small hospital alongside his research facility.

Beddoes was surprised by Georgiana's knowledge of chemistry. He said: 'She knows more of modern chemistry than I supposed any Duchess or any Lady in England to know'. Her interest was quite genuine. She had her own private laboratory at Devonshire House and had received tuition in chemistry from Henry Cavendish, the scientist relative of the Duke.

Georgiana tried to obtain the support of Sir Joseph Banks, President of the Royal Society, for Beddoes' project. Sir Joseph courteously but firmly refused. He stated that he had had his doubts about giving public support of any kind to a man whose extreme opinions threatened the present order of Society but, he claimed, his doubts were now confined to the effects of the gases upon patients, which he thought were more likely to be attended by mischievous than beneficial consequence. A second appeal to him by the Duchess met an equally firm refusal. Since Beddoes had published attacks on Banks and the Royal Society, accusing them of 'electing Members for the colour of their political opinions', it is not surprising he refused.

In the 1784 election Charles Fox was leader of the Whig party but Georgiana was its star. It may interest our American colleagues that she dressed, for this campaign, in the blue and buff which Fox had copied from the colours of George Washington's uniform. Her impact on the voters was so great that the government side descended to personal abuse. Most of their political cartoons attacked the Duchess rather than Fox.

Beneath her exuberant public image the Duchess had many private sorrows. She was not loved by her husband. Her best friend, Lady Elizabeth Foster, became the Duke's mistress. All three lived together for over 20 years. Georgiana was addicted to gambling, and readily gave money to good and other causes. At one time she admitted to debts equivalent to £4,000,000 in today's money. She borrowed from many people but her main banker was Thomas Coutts. Some of their letters indicate that he was feeling the strain. Her life was insured in favour of Coutts. Somehow or other Coutts was persuaded to act as the lead banker for the collection of subscriptions to Beddoes' fund. The association of a banker aspiring to royal patronage with Beddoes the revolutionary must have been difficult to arrange.

The politicians

Amongst the subscribers to this fund were three prominent politicians - Charles Fox and the Earls of Shelburne and Dartmouth. Fox spent most of his political life in opposition and had less opportunity to grant political patronage than the two earls. Lord Shelburne, later Marquis of Lansdowne, is of particular interest. Many of those attending this Meeting visited Bowood House, where Shelburne employed Joseph Priestley as librarian and scientific adviser, and also to educate his sons. Priestley left him in 1780 to go to Birmingham. It is said he regretted his dependence on a single patron; he preferred small grants from several wealthy individuals. There were other reasons. Lord Shelburne walked the corridors of power; he held the highest offices in government. He gave a personal subscription to Beddoes' fund, but when he was asked, by Matthew Boulton, to support an application for a government grant for Beddoes' project, nothing happened He could not be relied upon. One respected historian, Conor Cruise O'Brien, wrote: 'Shelburne was widely distrusted, and was more disliked than any other contemporary politician'. Walpole and Edmund Burke expressed stronger opinions.

The other earl who subscribed to Beddoes' fund was the Earl of Dartmouth. He, too, held high office in government. When he was Lord Privy Seal he secured the passage of a Bill to protect James Watt's patents and he gave parliamentary help to Matthew Boulton in several other projects, but not for Beddoes.

A Spanish supporter

From overseas, Beddoes received the support of Professor Gimbernat, Surgeon to the King of Spain. Gimbernat's use of pneumatic medicine in the treatment of hydrocoele was highly original.

The Lunar Society of Birmingham

Beddoes' most valuable patrons did not come from the nobility or the politicians. Support came from people who were only moderately wealthy. They were members of a group called the Lunar Society. This was a group of friends from Birmingham and adjacent towns, who met for dinner and discussion at each other's homes. They met once a month, on the Monday nearest the full moon. They would dine at two o'clock, and not part till eight in the evening. They hoped that the light of the full moon would facilitate a safe journey home. The society had no constitution, no officers, and kept no records. It had evolved from meetings of like-minded people such as Matthew Boulton of Birmingham - a manufacturer, Erasmus Darwin of Lichfield - a physician, and William Small - a Scottish physician who came to Birmingham after he had spent some years teaching mathematics at the College of William and Mary in Williamsburg, Virginia. One of his grateful pupils was Thomas Jefferson.

The Edgeworths

Beddoes had made friends with some members of this Society while he was in Oxford and before he came to Bristol, particularly with Erasmus Darwin, James Keir - a manufacturing chemist, and Josiah Wedgwood, the potter. When Beddoes arrived in Bristol he had no friends in the city. But he had a letter of introduction to another member of the Lunar Society, Richard Lovell Edgeworth, who was living in Clifton while one of his family 'took the waters'. Edgeworth had estates in Ireland and a seat in the Irish Parliament. A complex character, it was said of him that: 'he had a keenly inventive mind, polished manners, natural gaiety, facility in friendship, and a passion for the other sex which brought upon him four marriages and 22 children'. One of his children was Maria Edgeworth, the most celebrated novelist of the period. Edgeworth's polished manners were needed to persuade the landlords of Clifton to let their houses to Beddoes.

Beddoes fell in love with and married another of Edgeworth's daughters, Anna. Davy described Anna as 'the best and most amiable woman in the world'. Edgeworth had mixed feelings about his son-in-law. In a letter to a friend, he described him as:

> 'A little fat Democrat of considerable abilities, of great name in the scientific world as a naturalist and chemist - good-humoured and good-natured - a man of honour & virtue, enthusiastic and sanguine. ... His manners are not polite - but he is sincere and candid. ... The Doctor will settle at Clifton and if he will put off his political projects till he has accomplished his medical establishment he will succeed and make a fortune - But if he bloweth the trumpet of Sedition the Aristocracy will rather go to hell with Satan than with any Democratic Devil.'

Once again this draws attention to the problem of Beddoes' political views. But all the members of the Lunar Society subscribed to Beddoes' fund, whether or not they agreed with his politics or that gases could be curative. Wedgwood made the point that it was worth spending the money even if it was to prove they did not work. Some of the Society were interested in Beddoes' treatment of consumption because several members of their families had the disease. James Watt's daughter, Jessy, Honora Edgeworth and her daughter, and Sally Priestley Finch all died of tuberculosis, while Gregory Watt, William Withering and Tom Wedgwood were ill with it. One of them, William Withering, thought it necessary to publish a letter in a medical journal denying that a pneumatic cure for consumption had been found.

James Watt

Beddoes' most valuable supporter in the Lunar Society was James Watt, of steam engine fame. He designed and manufactured the apparatus for generating and administering the gases. Watt also tried to obtain the support of Sir Joseph Banks for Beddoes, but once again, Banks refused. James Watt junior, hearing of Banks' refusal, wrote: 'I suppose he has seen Beddoes' cloven Jacobin foot and it is the order of the day to suppress or oppose all Jacobin innovations such as this is already called'. James Watt senior, however, did obtain support for Beddoes from his Scottish academic friends. Their names add prestige to the list of subscribers. Beddoes showed his appreciation of Watt in his dedication of the second edition of their treatise on *Considerations on the Medicinal Use and on the Production of Factitious Airs*:

'To Mr.WATT

Dear Sir,

You will probably be startled when you read your name on the page destined to dedication: but I cannot prevail upon myself to send these Considerations a second time abroad, without acknowledging my satisfaction in having had you for a fellow labourer. To establish a new department in Medicine, would have exceeded my single strength; and I do not know of any person who could have afforded me such effectual assistance as you have done. .....

I am dear Sir,
Your's with sincere esteem,
Thomas Beddoes.

Clifton March 30. 1795.

Later in life, Watt was offered a baronetcy which he declined. Beddoes would surely have been pleased that his main supporter chose to remain a commoner.

PAIN, DISEASE AND THE ROMANTIC POETS

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The Romantic poets of the early 19th century with their preoccupation and advocacy of expression of feeling and a heightened awareness of the importance of the senses, chart through their letters and poems their thoughts and experience of mental and physical pain and disease at that time.

Coleridge and the Wordsworths

William Wordsworth (1770-1850) and S T Coleridge (1772-1834) had many connections with Bristol and the South West of England and it was not until December 1799 that Wordsworth moved with his sister Dorothy, to Dove Cottage, Grasmere, in the Lake District. Wordsworth was then 29 and Dorothy 27. Coleridge too moved north to Keswick in 1800 to be close to them.

Between 1800 and 1803, the years when Wordsworth was writing his spiritual autobiographical poem *The Prelude* and other poetry, his sister was keeping a personal journal. This was not intended for publication. Dorothy, like most women of her time, no matter how talented, lived in the shadow of her brother, writing out his poetry and devoting her life to his needs; so it is no surprise that her prose record of this time was not available to the public until 1897, 42 years after her death, under the title *Grasmere Journal*.

The entries have a directness and simplicity, a wonderful, detailed, vivid clarity depicting countryside and domestic detail, including frequent references to illness and pain. Between the end of May 1800 and the middle of June 1802 there are forty-four referring to either William, herself or Coleridge being indisposed. 'Headach', 'toothach' and 'bowels very bad' are frequent entries for all three. In addition, we find Coleridge had 'great boils upon his neck', and is 'rheumatic, feverish' and Wordsworth has 'threatenings of the piles'. There is a fascinating reference to a Miss Barcroft having the 'Liverpool Complaint and was riding out for the benefit of her health'. Perhaps this was some malady affecting her nasal passages?

The interesting thing is the lack of remedies recorded by Dorothy. The main cure for these problems was retiring to bed or going for a long walk or taking laudanum, which was opium dissolved in alcohol. One other interesting medical reference is her account of meeting a leech gatherer in 1800:

> 'Oct.3rd, Friday: His trade was to gather leeches. He said leeches were very scarce partly owing to this dry season, but many years have been scarce - he supposed it owing to their being much sought after, that they did not breed fast, and were of slow growth. Leeches were formerly 2s.6d. (per) 100; they are now 30s.'

Leeches were commonly used for blood-letting, a frequent and fashionable practice at this period. I believe that leeches are still used in modern medical practice for draining haematomas following plastic surgery procedures, but I suspect they are not collected for use in quite the same way as they were!

Wordsworth was inspired by this meeting with the leech gatherer to create his moving poem *Resolution and Independence* (1802) in which he states that the tenacity and acceptance of this man of nature has given him renewed hope for the future:

> He with a smile did then his words repeat;
> And said, that, gathering leeches, far and wide
> He travelled; stirring thus about his feet
> The waters of the ponds where they abide;
> 'Once I could meet with them on every side;
> But they have dwindled long by slow decay;
> Yet still I persevere, and find them where I may'. (lines 127-133)

Laudanum

Laudanum opium, mentioned by Dorothy Wordsworth, was inexpensive during the early 19th century and was easily procured. Not only is it efficacious in the relief of pain but it is also addictive, has side effects, and is potentially lethal; indeed, it was frequently used as an effective poison for suicides at this time.

Coleridge suffered from an intestinal disorder which plagued him all his life and also seems to have suffered from heart disease. His letters vividly record his pain, his wife's pain and his searches for reasons and remedies. He wrote to influential intellectuals and scientists of the day, including Sir Humphry Davy (letter, January 11, 1801), requesting information on the nature of pain and possible cures. He questions ordained friends on the reasons why God should allow such pain. Of his wife's labour pains he writes:

> 'Other pains are only friendly admonitions that we are not acting as Nature requires - but here are pains most horrible in consequence of having obeyed Nature-Queen. How is it that Dr Priestly is not an atheist?' (Letter, March 20, 1796)

He writes to his great friend Thomas Poole on November 5, 1796:

> 'On Wednesday night I was seized with an intolerable pain from my right temple to the tip of my right shoulder, including my right eye, cheek, jaw, and that side of the throat. I was nearly frantic, and ran about the house naked, endeavouring by every means to excite sensations in different parts of my body, and so to weaken the enemy by creating division. It continued from one in the morning till half past five, and left me pale and fainting. It came on fitfully, but not so violently, several times on Thursday, and began severer threats towards night; but I took between sixty and seventy drops of Laudanum .

Coleridge continues to describe the pain in detail calling it (by the Saturday) 'a giant fiend of a hundred hands', but records that his 'medical attendant' thinks that it is 'altogether nervous' due to 'excessive anxiety' and Coleridge thinks he might be right! He adds:

> 'I have a blister under my right ear, and I take twenty-five drops of landanum every five hours, the ease and spirits gained by which have enabled me to write you this flighty but not exaggerated account.'

It is not surprising that Coleridge became addicted. By 1802 he was taking 100 drops of opium a day, but there is evidence in his letters of November 1892 that he is trying to kick the habit and that he is suffering from diarrhoea, a classic symptom of withdrawal. There is little doubt that Coleridge was fascinated with the effects of opium and that he used the drug to enhance and explore his mental and creative process as well as to curb his physical pain. We can find direct and indirect influence in his poetry, in the strange and wild suffering of the *Ancient Mariner* and *Christabel*. Poems such as *Kubla Khan* and *The Pains of Sleep* (both published in 1816) show this well, the latter possibly, as Richard Holmes suggests, recording the nightmares experienced with opiate withdrawal:

> But yesternight I pray'd aloud
> In Anquish and in Agony,
> Awaking from the Fiendish Crowd
> Of Shapes & Thoughts that tortur'd me. (lines 14-17)

De Quincey

The tenant of Dove Cottage after Wordsworth was Thomas De Quincey. He had begun to take opium in 1804 for 'a painful affliction of the stomach' and 'excruciating rheumatic pains of the head and face'. However, de Quincey became hooked and records: 'Nobody will laugh long who deals much with opium: its pleasures are of a grave and solemn complexion'.

It is interesting to note that even then, De Quincey was aware that the efficacy of the pain relief, and the euphoria of the 'high' had to be balanced against the resulting low of despair of withdrawal, the melancholy depression familiar in some Romantic poetry. In fact, during his life De Quincey was famous amongst the medical world because, despite having taken so much opium, he was still alive - the amount he took should have killed him! He left his now famous *Confessions of an English Opium Eater* (1821) as a record of that time.

Keats

Consumption or tuberculosis was rife in the world in the 18th and 19th centuries and there was no cure. The artistic community was no exception to its ravages and the history of the 19th century is strewn with young victims. The symptoms of lethargy, fever and long coughing bouts eventually leading to the coughing up of arterial blood, resulted in a pale complexion and a frail body, which gave the ill a kind of transient beauty which was to become fashionable in a morbid way, and which was immortalised in works such as Puccini's *La Bohème* and Dumas' *The Lady of the Camelias*.

John Keats (1795-1821) was a trained assistant to a surgeon. He gave up his chance of an excellent career as a doctor in order to be a poet - a risky venture then as it would be today. He nursed first his mother and then his younger brother, Tom, through the final stages of TB and so first hand experience and his medical training enabled him to recognise the bright red colour of his own blood confirming his TB and his 'death warrant'. Shelley, another sufferer of TB, wrote to Keats on 27 July 1820, commiserating with him that 'you continue to wear a consumptive appearance'. Keats travelled to Rome in the final year of his life in a last attempt to try the possible cure of sunshine and kinder climate, but despite the close nursing of his friend, the artist Joseph Severn, he died. The exquisite drawing Severn made of Keats during his final night's tubercular fever forever stands as an artistic medical record.

This certain knowledge of death must have focused Keats' mind incredibly, and there is in his poetry an urgency and a desperation in his final letters to Fanny Brawne. His medical training gave him a cruel and harsh insight into the world of pain and distress of mankind, and he found it hard sometimes to equate the two sides of life and love, the happiness and despair - what Keats calls the 'Bitter sweet' of the world. He writes in *Ode to a Nightingale* of 'the weariness, the fever and the fret ...' of man's decaying life and sets down in ink the symptoms of consumption in *Ode on a Grecian Urn*: 'A burning forehead and a parching tongue'. But in his short young life Keats seems to have come to some conclusions about how mental and physical pain can be dealt with on a spiritual level. He encourages us in *Ode on Melancholy* to see melancholy as a positive emotion, and to accept it in its own beauty, and he suggests in a letter to his brother in April 1819 also that we should 'Call the world if you Please "The vale of Soul-making"', that each one of us is the product of our unique, 'bitter-sweet' experience during life.

Shelley

Shelley wrote in *Prometheus Unbound* (1819): 'I wish no living thing to suffer pain' (line 305, p.214). I think all the Romantic poets ask at various times: why is there so much pain and suffering in the world and why if there is a God does he allow it? These writers care about feelings, senses, their fellow men and women and the individual, what Steven Bruhm calls 'the self'. They provided the world with new insights into human mental and physical pain and ways to deal with it.

I suggest they have much in common with literary and medical men and women in this last year of the 20th century.

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HOW NITROUS OXIDE WAS INTRODUCED INTO CLINICAL PRACTICE: THE CASE OF CALIFORNIA

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This paper examines the introduction of nitrous oxide into clinical anaesthesia practice in California from 1846-1946. California is a good study site for the history of anaesthesiology because it was relatively isolated geographically for many years and because there were few medical institutions such as medical journals. In 1846 when anaesthesia was first successfully demonstrated in Boston, California was not part of the United States, either geographically or politically. Travel to California was exceedingly difficult, taking six months by land or six to eight months by ship, and the journey was hazardous. Cholera, pellagra, Indians and shipwrecks were among the dangers awaiting travellers to California, many of whom did not survive. Because of the great distance between the States and California and the travel difficulties, it took a long time for news to reach the State. Although the discovery of surgical anaesthesia reached the world's major cities within the next year, California did not learn of it until three years later, when the Gold Rush of 1849 began. The delay is understandable; during those three years, there was little reason for the news of anaesthesia to get to California. In 1846 there were only three doctors, all Army surgeons, in the State and there were no hospitals, no medical schools, no pharmacies, and no medical journals.

Effect of the Gold Rush

The Gold Rush of 1849 changed this isolation. Once gold was discovered, people from around the world rushed in 'to strike it rich'. This group included an estimated 1,200 physicians. Most 'forty-niners' did not strike it rich and many of the physicians practised medicine to survive. We know that some of these doctors brought their medical tools such as stethoscopes and microscopes and, no doubt, also brought ether and chloroform. This is suggested by the office sign of a University of Edinburgh graduate who arrived in 1849. His sign promised 'draws teeth painlessly'. He was probably familiar with chloroform as an Edinburgh graduate and used his ability to relieve pain with it as a way to attract patients to his tent-office in the tiny Gold Rush town of Placerville.

Ten years after the Boston demonstration, California's first medical journal began publication. Anaesthesia was well-established by then. The very first article in the new journal was on the possible additive effects of morphine and chloroform in a patient who died during surgery. Anaesthesia was mentioned in thirteen articles in the first volume, and chloroform was the most common anaesthetic. At this time, ether and chloroform were imported from Europe, but by the 1860s were being manufactured in the State.[1] The question for this study is how N_2O might have been added to anaesthesia practice in the State - how did nitrous oxide get to California, and when?

Arrival of nitrous oxide

It is known that Gardner Q Colton, the itinerant chemist whose 1844 demonstration in Hartford, Connecticut, led dentist Horace Wells to try nitrous oxide for dental work and then surgery, was in the State for several years during the California Gold Rush. There is no evidence that he administered N_2O while there.[2]

Sources for my study were primarily medical journals, starting with the State journals. There were nearly continuous State medical journals from 1856 to 1944 and there was only one at a time, making it relatively simple to get information on anaesthesia articles.[3] Journals of the earlier years were general, as there were no specialists. Anaesthesia journals began in the US in 1916 and, again, there was only one at a time until after World War II.[4] The medical journals were reviewed for articles on anaesthesia and the number of articles on N_2O were totalled. Reports of operations, which might mention the anaesthetic, were also checked; none mentioned N_2O. In fact, very few reports of operations noted the anaesthetic, including a report of multiple patients undergoing brain surgery. Once anaesthesia journals began, articles on N_2O written by Californians were totalled. These data were supplemented with information from miscellaneous sources: *The Minutes Book of the Southern California Society of Anesthetists* (the first anaesthesia society in the State) from 1919 to 1921, the transcript of a 1934 trial in which Los Angeles physician anaesthetists sued a nurse anaesthetist for practising medicine without a licence and, finally, any available meeting programmes of anaesthesia societies.[5]

Medical journals of the time often included abstracts from other medical journals. The first mention of N_2O in the State came from such an abstract. The noted anaesthetist, Dr Joseph Clover of London, reported on combining N_2O and ether in another journal; this was abstracted in the *Pacific Medical & Surgical Journal* in February 1877, 33 years after the first use of N_2O for surgical anaesthesia.[6] Two months later, Henry Gibbons, one of the State's most prestigious physicians, reported on his experience having teeth pulled under N_2O when he was visiting Philadelphia.[7] It appears Gibbons was familiar with the effects of nitrous oxide: 'I expected to feel its exhilarating effects, which I had many times experienced when inhaling it for amusement' (medical students of his generation in the US sniffed N_2O to get 'high' during N_2O parties). Gibbons became unconscious with this administration, rather than feeling exhilarated. He noted the benefits of N_2O and then stated that it was suitable for brief surgical operations. The major problem was its short duration. If the operation should go on longer than 1-2 minutes, Gibbons noted it could be inhaled again. He also noted that it was difficult to keep a supply in 'perfect condition'. This no doubt was to be a critical reason for the delay in using N_2O in clinical practice. Compared to ether and chloroform it was difficult to produce and transport.

After these reports, 24 years passed without mention of N_2O, except for a single brief 1881 abstract on Paul Bert's 'anesthesia car', in which operations were done under pressurised N_2O at various Paris hospitals.[8] In 1897, when our first physician anaesthetist, Dr Mary Botsford of San Francisco, began her practice, few others were interested. The paucity of interest in anaesthesia in general and N_2O in particular continued, with only two more articles describing N_2O in 1901 and 1905.[9] There was a ten year hiatus, and then an explosion of interest with nine articles and presentations on N_2O in 1915. This increased activity lasted until 1921. In 1925-27, another cluster of articles occurred. In this time period, the 'secondary saturation' technique was common. The hypoxic hazards were known and written about in the articles, but most patients were thought to tolerate them with little problem. Dr Botsford and her numerous trainees wrote many of these articles, demonstrating her leadership in developing professional anaesthesia in the State.[10]

From the non-journal sources, it was found that N_2O was more expensive than ether or chloroform. The Fee Schedule of the Southern California Society of Anesthetists listed fees of $25/hour for nitrous oxide and only $10/hr for ether.[11] (This cost differential was also present in the New York Society of Anesthetists' Fee Bill[12] from about the same time.) This was no doubt due to the need to purchase equipment, such as the new McKesson machine, for efficient delivery and to the higher cost to produce, package and transport N_2O. The 1934 trial transcript extensively described anaesthesia practice in Los Angeles. Physician anaesthetists did only general anesthesia, using N_2O, ether and CO_2. Nurse anaesthetists used ether and chloroform.

In summary, information on N_2O was available in California by 1877, but there is at present no evidence it was used for surgery until 1914. The years 1915 to 1921 were a time of great interest in N_2O anaesthesia, with a second period of lesser interest in 1925-26. In Los Angeles in 1934 N_2O was always supplemented with ether and CO_2, and only physicians gave it.

Decreasing use

Why did interest decrease after that? There was the higher cost of N_2O and the necessary apparatus. New agents such as ethylene, thiopentone and cyclopropane, introduced in the 1920s to 1930s, appeared as alternatives to straight N_2O. Most importantly, the hypoxic hazards of N_2O became clear. Los Angeles' neuropathologist, C B Courville, wrote an article in 1936 which in 1939 was expanded into a book: *Untoward Effects of Nitrous Oxide Anesthesia*. This documented hypoxic brain damage in patients who died during 100% N_2O anaesthesia. The book had a profound influence on the move to other anaesthetics.

Conclusion

Although this study did not find a perfect answer to the question how and when N_2O entered anaesthesia practice in California, it is possible to say it was used at a surprisingly late time and its popularity declined when other agents became available and as the hazards of nitrous oxide became better known.

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American Association of Nurse Anesthetists, Park Ridge, IL. Meeting programs were published in *California and Western Medicine.* If the presentation was later published (most were), it was not counted twice. Organizations meeting in the State included The Anesthesia Section of the California Medical Association (precursor of the present California Society of Anesthesiologists), the national association: The American Association of Anesthetists and the regional society: the Pacific Coast Association of Anesthetists.

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WHAT DREAMS MAY COME WITH NITROUS OXIDE

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Discovery of analgesia we trace to Humphry Davy's self administration of nitrous oxide 200 years ago. Priestley had shown that a candle burns brightly in N_2O, which may have led Davy and others to regard it as an alternative to oxygen, and hence safe to breathe without added oxygen. He experienced 'a high, an extraordinary degree of pleasure'.[1] After some three months of heavy consumption, he found himself and others to have become psychologically dependent upon it. He noted irritability, dysphoria, sleep problems and hyperaesthesia, and he was able to stop using the gas. Within two years he resigned from Beddoes' Institute and from medical research, pursuing basic physics and chemistry at the Royal Institution in London. He described his work with nitrous oxide as 'the dreams of misemployed genius';[2] but he recorded no bad dreams. Two score years passed, while many others used N_2O and ether for 'recreational' purposes, before the Yankee dentist Wells used N_2O for tooth extraction. These self-experimenters reported no lingering adverse effects of breathing laughing gas other than the consequences of their actions while under the influence, and the craving to repeat.

This presentation conveys my concern about long term psychological and neuro-physiological effects which may persist for weeks to months after a single terrifying dream experience occurring at the transition to unconsciousness with nitrous oxide.

A study on the potency of nitrous oxide

In 1960, five young anaesthesiologists at University of California - San Francisco attempted to determine the effect of altering PCO_2 on the potency of nitrous oxide.[3] The hypothesis was that hyperventilation to a low PCO_2 would synergize with N_2O. We thought hypocapnia would potentiate the effect of nitrous oxide and lower the concentration needed to impair ability to perform a task requiring vision, interpretation and manual response. Subjects were required to continually squeeze a blood pressure bulb to keep a leaky cuff pressure at 50 mm Hg. We found to our surprise that this coordinated task could be well performed until a sudden total loss of consciousness occurred, i.e. the subjects fell asleep. This end-point occurs at about 40% of MAC and is similar to 'Mac-awake'.[4]

In each subject there was a significant effect of PCO_2 on the potency of N_2O. However, we disproved our thesis, finding the opposite effect (Figures 1 and 2, taken from the original paper). The alteration of PCO_2 proved it to have about 4.0 times the anaesthetic potency of N_2O. For example, during mechanical hyperventilation to 20mmHg PCO_2 (2.7% below normal alveolar CO_2 concentration), 12% higher N_2O concentration was required to cause loss of coordination and of consciousness. By this test, CO_2 is 4.4 times more anaesthetically potent than N_2O. The result should have been expected. Henry Hill Hickman showed in the mid 1820s that CO_2 was an anaesthetic in animals.[5]

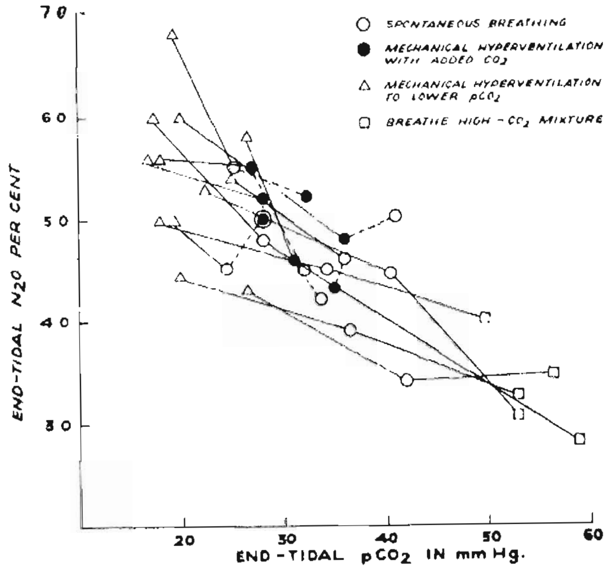

Figure 1. The concentration of N_2O and the PCO_2 in 12 subjects at the endpoint of failure of coordination

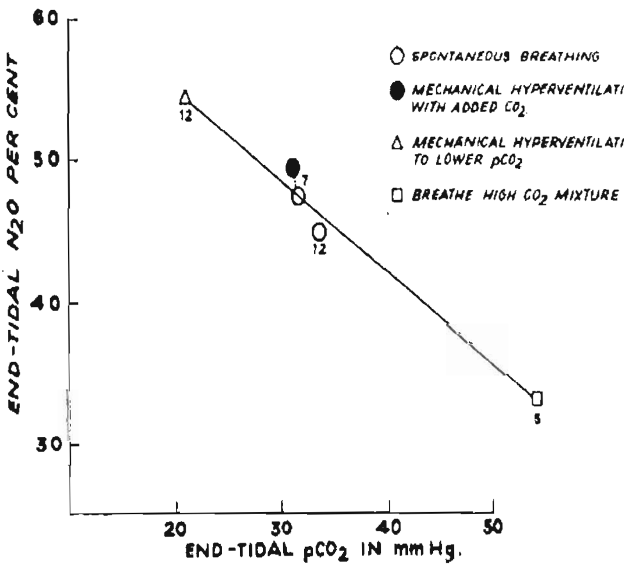

Figure 2. The effect of altering PCO_2 on the mean N_2O concentration required to reach the endpoint

A frightening complication

As a subject, I found myself nauseated by each run. In an attempt to prevent this nausea, I pretreated myself with meclozine, commonly used to avoid motion sickness. This time, at the point of falling asleep, I experienced a violent dream of death. This included a time distortion in which I thought an enormous time span had passed - in the order of years. There were visions of tunnels, bright lights at their end, and imagining that I now had seen the entire story of the creation. A strong impression was that I must forget everything I had 'seen' as I died (or awoke). I sat up screaming and tore off all the EEG leads and mask. I was initially convinced I had died and was experiencing an infinitely protracted, stretched out death dream. A schizophrenic state followed in which I quite clearly had two separate centres of awareness with differing interpretations of the present. One part of my consciousness believed I was dead, and that I was simply experiencing this very extended death dream, while the other maintained a normal awareness and understood that this was just a bad trip. The schizoid psyche gradually faded over a few days.

Unfortunately, over the subsequent six months vivid memories of the dream experience periodically recurred. Each was accompanied by tachycardia, sweating, anxiety, fear and trembling, somewhat like the autonomic rush half a minute after a near accident. Each episode climaxed at about one minute, faded away over a minute or two, then returned at lesser intensity several minutes later, and at longer and longer intervals, perhaps four or five times over the next 15 to 30 minutes. Such autonomic storms or seizures occurred at first many times a day, then with decreasing frequency and they finally ceased about six months after the event.

Extrapyramidal and drowsiness effects of concentrations of N_2O include euphoria, detachment and time distortion.[6] Nineteen percent of children anaesthetised only with N_2O and muscle relaxant reported dreams, but not nightmares or fright.[7] Abouleish and Taylor[8] found a 3.8% incidence of unpleasant dreams and recall during cesarean section with nitrous oxide using morphine and diazepam supplements. I suspect that the meclozine in some way facilitated formation of a large number of new synaptic contacts during the onset of unconsciousness, that the distortion or great extension of my inherent time-base formed a major 'experience' memory which was capable of driving a sympathetic nervous reflex, perhaps with a major release of catecholamines, both originally and with recall of the event. I was unable to determine what triggered the recalls. Remembering the event seemed to start the process over again. I failed to measure my arterial pressure during these storms. Perhaps this experience compares with the terrible dreams children report after induction of anaesthesia with ether, the smell of which can restore the dream for the rest of their lives. Others have told me the story resembles the long lasting after-effects of LSD. We need to be concerned that some long term psychic harm may be done by administration of anaesthesia. This may be due to facilitated synaptic imprinting of unpleasant 'dreams' at the moment when consciousness is interrupted, a process largely prevented by benzodiazepines.

We seldom inflict this type of bad dream on patients because we tend to use a variety of premedications and induction agents which do not facilitate memory of the sleep transition. It is important to realise that drugs can cause intense memory of unpleasant events generated entirely within our brains, and frightening remembrances may persist long after the agent is gone.

The best known thoughts about death dreams were Shakespear's:

> To sleep, perchance, to dream; - ay, there's the rub;
> For in that sleep of death, what dreams may come
> When we have shuffled off this mortal coil,
> Must give us pause.
>
> **Hamlet**, Act III, Scene 1

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TRIAL OF MUSCLE RELAXANTS IN CONSCIOUS VOLUNTEERS BRISTOL AND PARIS, 1951

Professor R Bodman (retired)
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The decade of the 1940s was a revolutionary one for medicine. Four developments particularly affected anaesthesia. First, a national blood transfusion service was set up with its headquarters at Southmead Hospital in Bristol, to collect and supply blood to the armed forces and hospitals throughout the country; although started as a war-time emergency measure, it became the British National Blood Transfusion Service. From this was developed the intravenous fluid replacement therapy, now universally used. Secondly, penicillin, discovered in Britain, was to be massively produced in the USA, primarily for the use of the armed forces; it gradually became available to the civilian population in the UK. Thirdly, the introduction of curare in the practice of anaesthesia had the effect of extending the bounds of surgery. These last two were costly and only slowly became generally available. Finally, in 1948, the National Health Service was introduced, which not only promised treatment for all, but also recognised anaesthesia as a specialty alongside medicine and surgery, so giving anaesthetists the opportunity to give up general practice and devote their whole time to the specialty.

This amounted to a revolution in medical practice. The drug houses were not slow to join in and new drugs were invented by chemists and tested in laboratory animals by pharmacologists. These were then randomly distributed to the medical profession most of whom had little notion of scientific method. The concept of 'ethics', I believe, was simply used to describe the correct professional relationship between doctor and patient. It was clear that there should be a step between the pharmacologist and the patient and this could be provided by the time-honoured method of trial on volunteers. After all, James Simpson tried chloroform on himself and his friends; more recently, the Professor of Anaesthetics at Oxford had repeatedly anaesthetised his first assistant and thrown him into a swimming pool to test survival equipment.

By 1948 curare was becoming available, though regarded with some apprehension by anaesthetists and alarm by surgeons; it was costly and had to be paid for with US dollars, which were in short supply. Harry Collier, pharmacologist at Allen and Hanbury, decided to look for a synthetic substitute in the bis-quarternary ammonium sequence - C5, C6, C10 etc; of which C6 (hexamethonium) had been found (incidentally by mistake) to have hypotensive properties and C10 as decamethonium had become popular as a short-acting depolarising relaxant.

Work at St Thomas's

I was at St Thomas's at the time and had started testing relaxants on volunteers - ourselves! At first the purpose was to determine how relaxants worked and on which groups of muscles. To allay the fear the subject would have of lying awake and possibly unable to breathe, the first dose started at 1 mg curare intravenously and increased incrementally on successive days. In this way it was possible ultimately to give larger doses; the largest dose given in this series was 18 mg curare. By subjective observation and by measurement, the sequence of effects on different muscles could be established (Table 1).

Summary of findings: if a relaxant drug is given slowly or in gradually increasing doses, paralysis will appear in different groups of muscles in the following order:

	Muscles	Evidence	
1.	Oculomotor muscles	Subjective:	double vision
2.	Eyelids	Subjective:	heaviness
3.	Facial muscles	Subjective:	heaviness
4.	Flexors of fingers	Objective:	measured with mercury manometer
5.	Tongue and pharyngeal muscles	Subjective:	difficulty in swallowing
		Objective:	obstruction of airway
6.	Masseter muscles	Objective:	jaw loose
7.	Abdominal muscles	Objective:	measured with Max. Expiratory Pressure test
8.	Intercostal muscles	Objective:	measured with Inspiration test
9.	Larynx	Objective:	patient able to speak
10.	Diaphragm	Objective:	adequate respiration maintained

Table 1. Order in which muscles are paralysed[1]

I have found that the order in which the muscles are paralysed is the same for Gallamine, d-Tubocurarine and Compound 20. The potencies and duration of action of these drugs, however, are different.

As the dose was increased the first effect noted was double vision, followed by heaviness of the eyelids and the facial muscles. The effect on the flexor muscles of the forearm was measured by squeezing a bulb connected to a manometer; the expiratory muscles - intercostals and abdominals - by blowing up a manometer, and the diaphragm by measuring maximum inspiration (Figure 1). The effects varied widely between individuals, so a consistent assessment had to be carried out on each person. An interesting observation was that on reaching the maximum dose tolerated by an individual, when the maximum inspiration was reduced to no more than the tidal volume, the larynx still functioned and the subject was able to speak.

Collier produced C15 and C20 which he deduced from animal experiments could be useful substitutes for curare. I got him to persuade Allen and Hanbury not to release the drugs until they had been tested on volunteers. It was as well, since C15 was soon found to produce 'pins and needles', a hot flush and tachycardia which we attributed to the release of histamine. This was confirmed by measuring intradermal skin weals and the drug was abandoned.

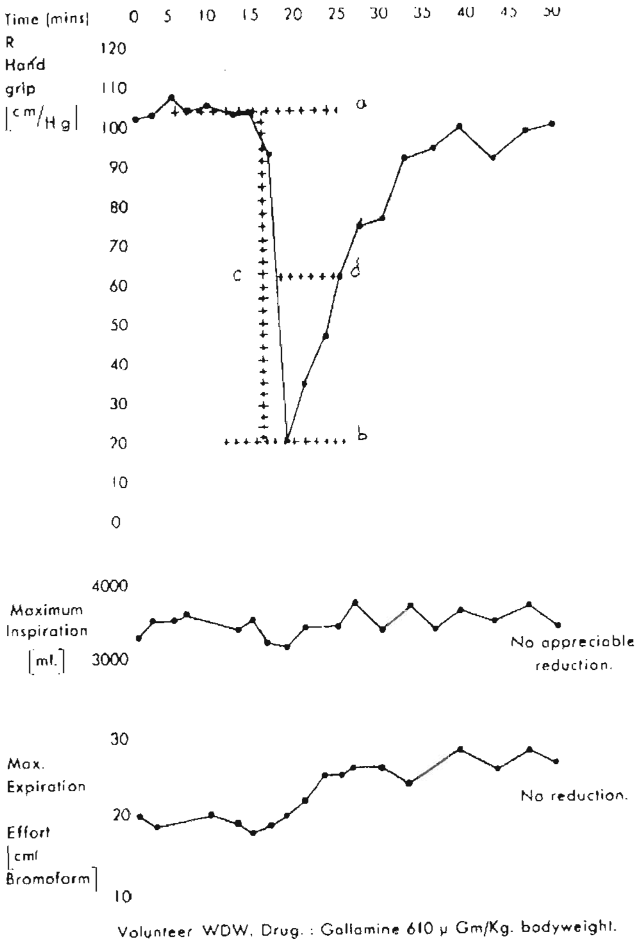

Figure 1. Sample test - hand grip, diaphragm and abdominal muscles[2]

Both Derek Wylie and Churchill-Davidson were involved in these early experiments. The latter pursued the hand-grip method in a more sophisticated form; with the assistance of the Physical Medicine Department at St Thomas's, he developed his nerve stimulator and the 'train of four' test.

Assessing C20 at Bristol

Meanwhile, in 1951, I had come to Bristol as Acting Head of the Anaesthetic Department when Ronald Woolmer was seconded to Copenhagen for a year to run the WHO School of Anaesthesia. I continued with the assessment of C20 which was found to have no undesirable side effects, histamine release was no greater than that produced by curare and its curarising effect was antagonised by neostigmine (Figure 2).

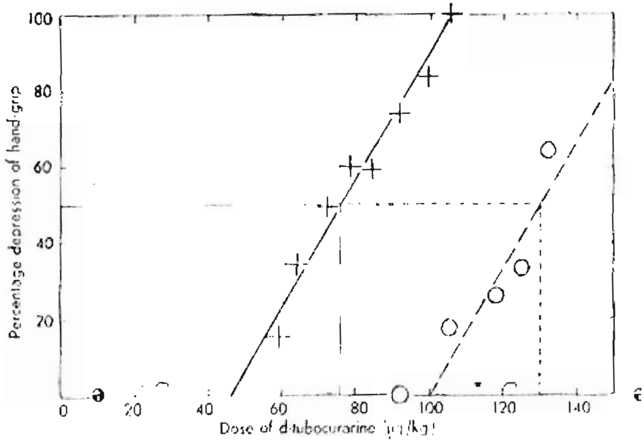

Figure 2. Hand grip before and after neostigmine[2]

To assess the antagonistic effect of neostigmine, a dose of 1 mg was given intravenously for ten minutes before the relaxant on each occasion and the assessment repeated. Histamine release was measured by intradermal skin weals; equipotent doses of curare and C20 and a saline control were injected intradermally on the palmar surface of the forearm and the size of the weals measured. Results confirmed in a number of subjects that curare and C20 were very similar, but that C15 produced weals about twice the size.

C20 was marketed by Allen and Hanbury as *Laudolissin* and officially named Laudexium BP. It had a useful life of 5-10 years as a substitute for curare. Though forgotten by anaesthetists, I found pharmacologists were using it for animal experiments many years later. The pharmacologists, incidentally, had regarded our experiments as nothing less than heroic - they being accustomed to carrying out their work on dumb animals.

Three papers were presented on this work. The first in Paris in 1951,[1] the second in the *British Journal of Pharmacology*[2] and the third, a clinical paper in association with H J V Morton and W D Wylie, was published in the *Lancet* in 1952.[3]

An historical meeting in Paris

The occasion of the first presentation is of historical interest. This was at the Congrès International d'Anesthésie et d'Analgésie held at the Salpêtrière Hospital in Paris in September 1951. This meeting was originally promoted by that indefatigable campaigner for anaesthesia, Dr Frank McMechan, editor of *Current Researches in Anesthesia & Analgesia*. He had arranged international meetings for a number of years between the United States and Canada, but to extend these meetings overseas he had hoped to arrange a meeting of the International Anesthesia Research Society (IARS) in Paris in 1940. Unfortunately, he passed away in 1939 and the war put a stop to the plan. However, the French Society proceeded, with the encouragement of the IARS, to hold the first truly international meeting of anaesthesiologists, which was attended by many members from the United States and Canada as well as many European anaesthetists. Some weeks later a second meeting was held in

London, sponsored by the Association of Anaesthetists of Great Britain and Ireland. From these first considerable meetings of anaesthetists from both sides of the Atlantic sprang the concept of the World Federation of Anesthesiologists - the 1st World Congress was held in Holland in 1955.

Two postscripts

In Paris, I was honoured by sharing a session with Dr Harold Griffith, the man who introduced curare into clinical practice, and at a magnificent reception given by the Paris prefecture in the Hôtel-Dieu I also shared a bottle of champagne with General Harry K Beecher, the man who prohibited the use of curare by anaesthesiologists in the US armed forces during the Korean war!

On 9 October 1953, shortly after the Korean war ended, the BBC described our work in a radio programme entitled *Curare and its Descendants.*

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McKESSON IS NOT HERE TO DEFEND HIMSELF

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Elmer McKesson was born in 1881 in Indiana and died suddenly in Toledo, Ohio in 1935. He started practice as a specialist in anaesthesia in 1907. At the Second International Symposium on the History of Anaesthesia, Dr Lucien Morris elegantly summarized McKesson's contributions to the art and science of anaesthesia.[1] He taught that anaesthetics are cardiovascular depressants, that the signs of anaesthesia depth are muscular and the character of respiration is important; he taught mouth to mouth respiration to resuscitate infants and he incorporated the means to exert positive pressure in his equipment. He was aware of the dead space to tidal volume ratio; he knew that at a given inspired concentration, depth of anaesthesia is a function of time. He tried Jackson's closed CO_2 absorption technique; he was one of the first to record blood pressure regularly during surgery. For his time he was remarkably advanced and sophisticated in his knowledge and anaesthetic practice. It is worthy of note that he also was aware that the vomiting of mountain sickness is due to hypoxia.

My interest in Elmer McKesson began in 1962 when a dentist on the Holloway Road in London tried to get me to use McKesson's secondary saturation technique for some extractions. I had heard of the method but was too frightened to use it. She asked me to leave and I did not get my two guineas. I have never been able to reconcile what I have since discovered about the man, who was undoubtedly brilliant, with his use of a deliberately hypoxic technique of anaesthesia. I will explore this paradox by trying to answer several questions.

Did McKesson actually advocate hypoxemia?

I believe he did. Let us look at what he said in his first paper on the subject, published in 1911. Although this paper is primarily about control of rebreathing we can see his mindset regarding oxygenation.[2]

> 'Nitrous oxide when administered pure without air or oxygen produces anesthesia in about 45 to 60 seconds after which cyanosis, muscular twitching, vomiting, slowing of the pulse come on in rapid succession, and if the gas is still pushed, spasm of the respiratory muscles takes place. If at the time anesthesia begins, a sufficient supply of pure oxygen is inhaled with the nitrous oxide, anesthesia continues without the development of symptoms of asphyxia……. An excess of oxygen administered with nitrous oxide produces no untoward symptoms, but dilutes the nitrous oxide to a point at which anesthesia is superficial or altogether absent. As a rule oxygen cannot be used in larger amounts than 20% without resulting in superficial anesthesia and muscular rigidity. But a smaller amount than this is sufficient to maintain a pink colour of the most dependent ear or fingernail.'

So far, so good, but later in the paper he describes the actual technique he used:

> 'No oxygen is given until the air is washed out of the lungs and apparatus by ten to fifteen respirations; but before anesthesia is established, or cyanosis and jactitation appears, the oxygen valve is opened to the five or ten percent position.'

In a paper he published in 1915,[3] which was primarily devoted to the physiology of fractional rebreathing, we find a most interesting paragraph. It is important to study carefully the words he used because they reveal his concepts of the physiology of oxygenation:

> 'Rapid breathing in anesthesia, especially with N_2O, is probably due to restricting oxygen in the nerve cell to amounts capable of supporting life functions only. The oxygen restriction sets up a protective train of impulses resulting in rapid respirations, for it is common knowledge among N_2O-O_2 anesthetists that a rich oxygen mixture for two or three breaths will invariably slow, and sometimes even stop, respiratory efforts for several seconds, but as the surplus of oxygen is consumed, the patient soon resumes rapid respiration. With ether, the oxygen restriction is probably of a chemical nature.'

What does he mean by 'capable of supporting life functions only'? And with his comment on ether he appears to equate anaesthesia with hypoxemia. In his 1920 paper we read:

> 'In a primary saturation only the actively circulating blood is saturated before oxygen must be administered. There remains in the muscles and in all other tissues, considerable volumes of nitrogen and oxygen, which in the early minutes of narcosis dilute the nitrous oxid, which prevents a deeper anesthesia. In order to displace more of the non-anesthetic gases in the body with nitrous oxid, the technique to be described as secondary saturation has been devised.'[4]

Here McKesson contradicts himself. He knows that cyanosis and jactitation, which one can safely assume are hypoxic seizures, are the result of tissue hypoxemia and at the same time he assumes that 'considerable volumes' of oxygen remain in all other tissues. He continues:

> 'It was soon learned that cyanosis, a dilated pupil, and apnea were easily corrected by inflating the lungs once or twice with oxygen, and that while these signs could not be disregarded or neglected for a moment when they became apparent, nevertheless, the patient was in no serious danger if oxygen were available and put into the lungs promptly after saturation had occurred.
>
> When a patient has been reoxygenated after resaturation, complete muscular relaxation followed, and a patient who, prior to that time, had been too rigid for easy abdominal exploration was now ideal from the surgeon's point of view.'

But he makes no suggestions here or anywhere else as to the mechanism of this relaxation. Thus, we must assume that at this point some hypoxemic 'stunning' of the brain and spinal cord had occurred. Later he says:

> 'Many times patients have been brought from what appeared to be a well developed fourth stage, with dilated fixed pupils, the deepest cyanosis, complete spastic apnea and general board-like rigidity, into a beautiful, placid relaxed pink patient in from 10 to 20 seconds with every appearance of normal slumber.'

And later:

> 'A patient will tolerate very deep cyanosis for some minutes, a moderate amount for hours and a slight cyanosis for long periods if due merely to a restriction of oxygen administered to the lungs for absorption.'

There are many more examples to be found of what might be called pseudo-physiology. He published many papers and gave many lectures on the subject but never wrote a book about it. His professional partner, friend and acolyte, Dr Fred Clement did write a book which included the text of a lecture McKesson gave at another Joint Meeting in Britain. This was at Nottingham in July 1925 when the International Anesthesia Research Society joined the Section of Anaesthetics of the British Medical Association. McKesson's presentation included these opinions:[5]

> 'The anesthetist alters the gaseous content of the tissues to effect a reduction of oxidation or metabolism in certain of the more highly specialized nervous tissue without similarly affecting the metabolism of other tissues.
>
> Anesthesia, then may be due to the dilution or dispersion of the oxygen molecules so that certain cells are unable to find enough oxygen with which to maintain metabolism or chemical activity up to the usual rate.
>
> The variation in the oxygen/nitrous oxide mixture is very small indeed. Often as little as 1% perceptibly alters the depth of narcosis.'

He then went on to describe his apparatus which indeed could provide very fine and accurate control of the proportions of the two gases.

Should he have known better?

One must assume that this man who, prior to becoming a doctor was the headmaster of a school in Indiana, read widely.

In 1868, Edmund Andrews, the Professor of Surgery wrote in the *Chicago Medical Examiner*:[6]

> 'I have for some time been experimenting, to see whether by the addition of free oxygen to the nitrous oxide, a mixture would not be obtained, by which the patient might be anesthetized for an indefinite period without danger of asphyxia, and thus render gas available for the most prolonged operations of surgery.'

His paper then describes his experiments on rats and his observations of nitrous oxide/oxygen mixtures used by several dentists he knew in Chicago. He concludes:

> 'It is my impression that the best proportion of oxygen will be found to be one-fifth by volume, which is the same as in atmospheric air.'

Gwathmey, in the first edition of his massive textbook says:[7]

> 'It is especially to be remembered that the administration of nitrous oxide alone belongs to the past and not to the present period of the science of administration of anesthetics'.

Henry Lyman in 1881 said, and this was based on his awareness of Paul Bert's high pressure experiments:

> 'If inhaled without dilution it (nitrous oxide) produces asphyxia by exclusion of oxygen from the blood. .... In order to saturate the system with nitrous oxide sufficiently for the production of anesthesia, the tension of the gas must equal the pressure of the atmosphere.'[8]

This last remark foreshadowed Eger's concept of MAC (minimal alveolar concentration).

Paluel Flagg, in his textbook, said:

> 'It is true that in order to obtain the longest "available anesthesia", it is necessary to push gas to an asphyxial degree where oxygen is not employed. Such a procedure is in bad taste to say the least, and should not be practised.'[9]

And suppose McKesson had read the British literature on the subject, what would he have found? Let us just look at two authorities. Dudley Buxton in the first edition of *Anaesthetics; Their Uses and Administration*, published in 1900 wrote:

> 'If given without sufficient care or knowledge bad results may accrue, through the supervention of symptoms due wholly and solely to the accompanying but unnecessary deoxygenation of the blood and tissues.'

Frederick Hewitt in a little book of 1897 titled *The Administration of Nitrous Oxide and Oxygen for Dental Operations* had this to say:

> 'A careful study of every fatality which has been recorded in connection with the use of nitrous oxide gas shows that in most, and probably in all cases in which this agent has caused death, absence of oxygen has been primarily responsible for the occurrence.'

Dangerous advocacy

Did McKesson's advocacy lead to widespread use of the technique? I believe the short answer to this is 'Yes'. Harsh as this judgement may be I believe he fooled a lot of the people a lot of the time. He even fooled a number of distinguished colleagues. In 1920 the National Anesthesia Research Society awarded him a prize for his work using nitrous oxide. As late as 1941, in the second edition of Macintosh and Bannister's *Essentials of General Anaesthesia*, on page 54 one reads, referring to nitrous oxide:

> 'To be effective in an average patient, its weak anaesthetic properties have to be reinforced deliberately by a reduction of the oxygen intake to such a level that some degree of cyanosis is usually noticeable. Cyanosis is here unavoidable and not of serious import.'

Later in the book the Oxford authorities say:

> 'The weakness of the anaesthetic properties of this agent may be thought to imply that it can never be used successfully for major surgery. Such use is indeed possible but to obtain good results the effect of N_2O must be reinforced by powerful premedication, by basal anaesthesia, or by some other method reducing the patient to the C3 condition, e.g. by the "secondary saturation" technique of McKesson.'

However, for this combined British and American meeting, I would like to recall what Langton Hewer wrote in 1944 in *Recent Advances in Anaesthesia and Analgesia*:[10]

> 'It should be remembered that pure nitrous oxide anaesthesia is used extensively in America even for major surgery sometimes with the secondary saturation technique. It seems probable that gross anoxia for a considerable time is not very uncommon and this may account for the absence of such reported cases in Great Britain where the toxicity of oxygen lack is more fully appreciated.'

By no means everyone believed him, even in the 1920s. For example, Guedel at the 1922 meeting of the Mid-Western Associations of Anesthetists said:

> 'Our object then is to carry into the nerve cell a proportionate mixture of the gases with sufficient oxygen for adequate tissue respiration and all the nitrous oxid that can be crowded into the remaining cell space.'[11]

But it is a well thought out and beautifully written paper presented in 1921 by two California ladies, that I like the best. They were Dorothy Wood and Mary Botsford who carefully analysed all the relevant literature before proceeding with their own experiments. They found that "no person tested was able to stand an oxygen tension of less than 15%......'[12]

How can we explain McKesson's behaviour?

There is evidence in his writings to support a variety of plausible speculations. Was he currying favour with the surgeons at the patient's expense? In his 1920 paper he said:

> 'Another phenomenon was observed .... which has since been a most important means of securing a flaccid abdominal wall. When fully utilized it has made it possible for me to obtain for the patient the full advantages of a pure gas-oxygen anesthesia and to eliminate from my practice the unpleasant and sometimes disastrous sequelae which even a small amount of ether produces.'

The phenomenon was this: When a patient had been reoxygenated after being resaturated complete muscular relaxation followed, and a patient who, prior to that time, had been too rigid for easy abdominal exploration was now ideal from the surgeon's point of view.

Was his motive political? In many of his publications he strongly emphasises that his saturation methods should only be used by doctors who specialise in anaesthesia. At a joint meeting of anaesthetists and gynecologists held in September 1919 in Cincinatti, he and a surgical colleague, Dr Moots gave a paper titled 'Surgical Barrage.'[13] They said:

> 'We have considered all the arguments in favor of the non-professional anaesthetist, and in times past were inclined to admit that in some of them there existed a partial truth, but with our profession home from the war and such a goodly percentage ready to devote their lives to the study of anesthesia, there now exists no reason for any surgeon who is unselfishly devoted to raising the standards of hospitals and surgery, to encourage in any way non-professional anesthesia.'

And later:

> 'It is with extreme regret on our part, that upon our return from the war-ridden countries, we found the legislature of our own great state, Ohio, legalizing non-professional anesthesia. Already we hear the jeers of the non-medical cults concerning the all too apparent insincerity of some of our leaders regarding their desire to really raise the standard of the medical profession.'

Was his motive commercial? One of the best advances he made in the development of anaesthesia apparatus was the device that allowed very rapid and accurate adjustment of the inspired oxygen percentage. Did he develop a technique of anaesthesia which required such accuracy, that he created a market for the equipment?

In *Under the Influence*, W D A Smith quotes from a paper by Skeel from the Cleveland Clinic:

> 'Exploitation by those personally interested is, I am sorry to say another very potent reason for the popular belief in the safety of nitrous oxide. For this the exuberance and enthusiasm of some very prominent members of the profession are directly to blame, and I believe that could they have foreseen the results of their utterances they would have been more circumspect in what they said and wrote. Working under the most favourable circumstances with expert anesthetists they have not hesitated to proclaim the entire safety of nitrous oxide with the result that large numbers of medical people and dentists have equipped themselves with the necessary apparatus and after observing half a dozen administrations, have rushed home to announce the possibility of anesthesia without danger, discomfort during its use or uncomfortable after effects.'[14]

Was it arrogance? I have been quite unable to find in any of his papers any reference to earlier work on the physiology of oxygenation. Did he so delude himself that, because he was a mechanical genius and highly successful business man, he could theorise and make pronouncements and ignore the views of his peers and predecessors, or was it just a simple misunderstanding of respiratory physiology?:

> 'Cyanosis is too often confused with the really dangerous condition of anoxemia. Cyanosis results when the amount of oxygen in the blood is insufficient to saturate the greater part of the hemoglobin present. Anoxemia on the other hand, indicates a reduction of the free or essential oxygen in the tissues.'[4]

Even if none of these speculations is correct there is little doubt that by proselytising his methods, McKesson was responsible for the injury or death of many patients. It was the work of the great neuro-pathologist Cyril Courville which demonstrated the devastating consequences from the use of nitrous oxide without oxygen.[15]

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THE FIRST GENERAL ANAESTHETIC IN BRISTOL

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Bristol was among the cities that reported the use of ether as an anaesthetic within the first weeks of it being demonstrated in London, although there is some doubt about the precise date when the operation took place.

The suggested dates of first ether anaesthetic in Bristol:

30th December 1846 *Lancet*
31st December 1846 *London Medical Gazette* and *Bristol Mirror*
1st January 1847 *Bristol Gazette, Felix Farley's Bristol Journal* and *The Times*
4th January 1847 *Development of Inhalational Anaesthesia*
31st August 1850 *Short History of the Bristol General Hospital*

The last two dates are clearly wrong. Since no hospital records remain, one is left with a choice of three days, 30th December and 31st December 1846, and 1st January 1847. We can eliminate 30th December. The only letter referring to this date was written two weeks later, appearing in the *Lancet* of 16th January.[1] It was written by the surgeon, J G Lansdown, and started: 'Sir, I find, from Dr Fairbrother, that he has sent you a letter respecting the operation I performed on the 30th ult., whilst the patient was under the influence of ether.'

The letter that Dr Fairbrother had sent to the *Lancet* was acknowledged in an earlier issue[2] but was never published. However, it did appear in the *London Medical Gazette*.[3] This letter started: 'Surgical operation without pain: - Thursday, 31st December, a young man ....' Dated 4th January, this is obviously better evidence; Fairbrother is more likely to have remembered the actual day of the operation after four days, than Lansdown after two and a half weeks. The newspapers vary in their detailed accounts of the procedure as much as they vary in the day they said it occurred. Not only do they disagree about the date, the 31st or the 1st, but compound the disagreement by specifying Thursday and Friday.

The Place

There is no doubt that the anaesthetic was given at the Bristol General Hospital. The hospital occupied 11, 12 and 13 Guinea Street, having been founded in 1832. It was expanded in 1858, and again in 1875. A Bristolian of one hundred and forty years ago would easily recognise the buildings that the NHS inherited, and still occupies today.

The patient

The patient was a young man who had a left above-knee amputation: 'rendered necessary by a white swelling of three years duration'.[3] As far as can be ascertained, he did well after his operation, and at the end of January was 'quite well, and in a state to leave the hospital; no unfavourable symptoms of any kind having manifested themselves'.[4] The surgeon, James

Goodall Lansdown was, in 1846, the senior surgeon to the Bristol General Hospital. He is dealt with more fully in Dr Bennett's paper (see page 86).

The anaesthetic

The method of administration of the ether, using a common bladder, was described in a letter to *The Times*[5] written by a well known Bristol chemist, William Herapath, and dated 1st January 1847:

> 'No complicated apparatus is necessary, nor any extraordinary care in purifying the ether. A common, but very large, bladder should be fitted with a collar to which an ivory mouthpiece with a very large bore can be screwed without the intervention of any stopcock; pour in about an ounce of good common ether (mis-spelt in *The Times* as either), and blow up the bladder with the mouth till it is nearly full; place the thumb on the mouthpiece, and agitate the bladder so as to saturate the air in it with the vapour; as soon as the patient is ready for the operation, close his nostrils, introduce the mouthpiece and close the lips around it with the fingers. He must now breathe into and out of the bladder, and in about one or two minutes the muscles of his lips will lose their hold. This is the moment for the first cut to be made. In two or three minutes, the effect will begin to disappear; the mouthpiece should again be introduced, and this repeated as often as required. If the pulse should indicate a sinking of the patient, a little wine will restore him.'

Significantly, Herapath then added:

> 'I have no doubt but the inspiration of nitrous oxide (laughing gas) would have a similar effect upon the nerves of sensation as the vapour of ether, as I have noticed that persons under its influence are totally insensitive to pain, but I do not think it would be advisable to use it in surgical cases, from its frequently producing an ungovernable disposition to muscular exertion, which would render the patient unsteady, and embarrass the operator.'

The anaesthetist

There are two candidates for the honour of giving the first anaesthetic in Bristol. They have both been mentioned already - Dr Alexander Fairbrother and Mr William Herapath. As with the date, the evidence differs as to whom the honour is due. Three sources, the *London Medical Gazette*,[3] the *Bristol Mirror*[6] and *Felix Farley's Bristol Journal*[7] use the same wording:

> 'At the suggestion of Dr Fairbrother, the senior physician to the hospital, Mr Lansdown, the operating surgeon, was induced to try the effect upon the patient of the inhalation of the vapour of sulphuric ether. By this mode, the patient is thrown into a state of utter insensibility, by means of the bladder used in imparting the laughing gas, into which Mr Herapath introduced the ether, and caused the patient to inhale the vapour. After one minute and a half the patient was unconscious; the surgeon then commenced his incision. After the lapse of two or three minutes, Dr Fairbrother again administered the vapour, keeping his fingers on the patient's pulse, and watching his breathing.'

From this it would seem that Mr Herapath induced anaesthesia, and Dr Fairbrother then took over and maintained it. The word 'again' in 'Dr Fairbrother again administered the vapour' must refer to the administration, and not the administrator. The *Times* report[5] is identical, except that by omitting the sentence 'by this mode ....inhale the vapour', all mention of Herapath administering the ether is also omitted. This is compensated for by the long letter from Herapath on the method of administration which then followed.

The *Bristol Gazette*[8] under the headings: 'Painless Surgical Operations' and 'Successful application in Bristol' gives Dr Fairbrother the honour of suggesting the use of ether, but Mr Herapath the sole honour of the administration. It seems relevant to compare the careers of these two protagonists, to see which was the more likely to have had the foresight to recognise the huge advantages of the new discovery of ether as employed in London, and then the courage to use it in Bristol.

Dr Alexander Fairbrother

Fairbrother was born in 1809, graduating at Edinburgh in 1836. He was appointed Physician to the Bristol General Hospital in 1838 and held the post until 1853. He must either have read the reports of the use of ether in the *Lancet*, or heard by word of mouth. In his letter to the *London Medical Gazette*,[3] he first describes the events and then makes a few comments. After citing the temporary insensibility produced by the America authorities, he states:

> 'In the present case, by keeping my fingers upon the pulse, and closely watching his respiration, varying the process by giving wine (leaving off at intervals all the means, and allowing him to breathe the atmospheric air), he was kept exactly in that state of unconsciousness that was desired, from which he awoke directly after the operation was completed ...... and the man appeared as though he had suffered no pain ...... I should not hesitate to superintend a case requiring a longer duration of the application than the present, which occupied from fifteen to twenty minutes.'

I leave Fairbrother also to Dr Bennett but if he really was the instigator of the use of ether in Bristol, surely the authors of his various obituaries, both medical and lay, would have recorded the fact, as they did the interest in the subject shown by J G Lansdown.

Mr William Herapath

William Herapath was a man of rare distinction, who rose from a very humble background to follow two very separate but equally important careers. He was born in Bristol in 1796, his father being a maltster in the St Phillip's area of the city. Initially, he joined the family business but soon became more interested in chemistry, and it was in this field that he achieved national fame. In 1828, he started to give lectures at the Bristol Medical and Surgical School, which had been started by Henry Clark in 1826. The Apothecaries' Hall recognised these lectures immediately, while the College of Surgeons waited until 1831. He was thus one of the founding professors of the Medical School, holding the post of Professor of Chemistry andToxicology from 1828 until his death. His lectures were regularly advertised in the local press, and were open to the public. A series of public lectures during the autumn of 1836 were particularly popular, so much so that they had to be repeated twice. These have been described before[9] so I will limit myself to two quotations. With respect to nitrous oxide, on 16 November 1836 he:

'.... expatiated on its discovery, and more particularly on the fact that in our native city the discovery of its laughable properties was first discovered by Sir Humphry Davy, whilst with Dr Beddoes, whose work written at the time on this important discovery he recommended all present to read.'

'In the majority of those who took the Gas it occasioned a pugnacious tendency.... it was a matter of congratulation that a magistrate was present to prevent a breach of the peace. The scene was, in fact, as truly comic as can well be conceived - one dancing with the greatest enthusiasm, another bowing with the most perfect grace, a third standing in 'solemn silence'. Not the least amusing exhibition was that of a gentleman who on taking the gas was seized with a fit of the most excessive politeness, several times thanking Mr Herapath for his kindness, and accosting everyone with whom he came in contact with the most polite thanks for some supposed act of civility. It is impossible to depict the varied effects of this singular gas as displayed that evening. To form any correct idea of the effect we would recommend our readers to visit the Mechanics Institution on Wednesday, the 30th instant, when Mr Herapath, at the request of the Company and with a view to benefit the funds, has kindly consented to repeat the experiments at the conclusion of his fifth and last lecture.'

On 22 December 1836, it was noted how Herapath:

'... roasted a piece of beef weighing nine pounds, a couple of fowls, a plum pudding, and boiled some potatoes by means of a gas apparatus. The viands were pronounced by the company, who all partook of them, to be excellently well done, and from ere long gas fires will be found in the house of all grate economists, as gastronomy be, as it should, the science of cooking by gas. On Friday next, the Laughing Gas is to be administered to several happy youths home for the holidays.'

As a forensic expert, he came to prominence after his evidence at the trial of Mrs Burdock in 1835. She had used arsenic to poison her lodger, a Mrs Smith, and was hanged, largely as a result of Herapath's chemical examination of the corpse, exhumed fourteen months after burial. After that, he was asked to make analyses in all the great poisoning causes célèbres culminating in 1856 in the case of William Palmer, the notorious Rugeley poisoner. On this occasion he appeared for the defence, which lost.

It was in the role of local politics that he was best known to the population of Bristol. He held, from his youth, extreme liberal views. 1831 found him as Vice-President of the Bristol Political Union, a strongly radical club, actively working for the Great Reform Bill. When, on 29 October, the Bristol Riots broke out, it was noted that while the posters of the authorities, urging the crowds to disperse, were torn down, Herapath's were left up. Indeed, the many reactionary Tory elements in the town blamed his organisation for much of the trouble. After the Municipal Reform Act became law in 1835, Herapath was among the few liberals who were elected to the reformed Council, and he held various seats until 1863. However, his pretensions to public office, and the fading of his radical views, gradually lost him much of his support. He had a strong interest in the Bristol General Hospital. He was present and spoke at a public meeting calling for its formation, held on 21 September 1831.[10] His connection with the radical element in the city, though, meant that when the election of the committee to run the hospital took place, an event actually postponed by the riots, he was not chosen.

Our main interest, however, is in his brief involvement with anaesthesia, which was not confined to the hospital. Having induced the first general anaesthetic in Bristol, Herapath did not entirely withdraw from the scene:

> 'On Tuesday (i.e 11 January), a young lady from Stoke Bishop, who for some time has been suffering from toothache, was induced to try the expedient of inhaling ether, and Mr Herapath kindly undertook to administer it. She went to Mr Gordon's, in Park Street, and being rendered insensible to pain, the operation of extraction was successfully performed without the least pain to the lady.'[11]

William Herapath died on 13 February 1868, at his home, the Manor House, Old Park, aged 71, and is buried in Arnos Vale Cemetery. Bristol has not entirely forgotten Herapath. A rather scruffy street in the Barton Hill area of the city is named after him.

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THE ECLIPSED DAWN OF ANAESTHESIA IN BRISTOL

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The first surgical procedure to be carried out in Bristol under general anaesthesia was on Wednesday 30 December 1846 at the hands of an anaesthetist who was a university professor – a probably unique and certainly remarkable circumstance for that period. Equally unique was the method of administration which was by means of a 'common, but very large, bladder ... fitted with a collar to which an ivory mouthpiece with a very large bore can be screwed without the intervention of any stopcock'.[1] This was in contrast to the apparatus being then promoted by Boott and Robinson,[2] sometimes known as the Squire or Hooper inhaler, which was adopted by all the early administrators throughout the kingdom.

The Bristol technique probably arose from the system for nitrous oxide inhalation formerly employed at the Medical Pneumatic Institution in Hotwells, Clifton, Bristol, by Humphry Davy and seen in pictorial descriptions of his later demonstrations at the Royal Institution in London.[3] William Herepath, Professor of Chemistry and Forensic Pathology at Bristol Medical School, adopted the technique for his public demonstrations of the effects of nitrous oxide during his courses on domestic chemistry.[4] In applying the method to the inhalation of ether it could be postulated that Herepath had considered its vaporisation by this means for quite some time. As a forensic chemist, his knowledge of the mode of entry and exit of drugs would outstrip many who would be charged with introducing ether into hospitals throughout the land. Herepath's expertise was not retained beyond this first occasion. Clearly he was not a member of the Hospital Staff, and there were, as we now know, both surgeon and physician interested in promoting the effects of ether – but perhaps from opposing standpoints.

Dr Alexander Fairbrother

One such physician was Alexander Fairbrother who was appointed to the Bristol General Hospital in 1838, some six years after its opening in Guinea Street. Little is known about his early career but he became increasingly well known for being at variance with his colleagues on many matters. A point of particular irritation to him was the failure of the Hospital Committee, of which he was a member, to allow its proceedings into the public domain. This was eventually to become a resignation issue when in 1853 Dr Fairbrother wrote to the local press:[5]

> 'To the Editor, etc Sir, be so good as to insert the following,
>
> Yours Alexander Fairbrother.
>
> As Dr Fairbrother will never consent to belong to any institution seeking to hide from the public, to whom it owes its means of existence, the Proceedings of their Committee, he at once resigns his office of Physician to Bristol General Hospital.
>
> 36 Park Street May 16th 1853.'

During his time at the Hospital, Fairbrother had fulfilled in abundance the tenets of the institution – the 'devotion to his professional engagements, and the enlargement of the boundaries of general science to advance the happiness and welfare of mankind'.[6] He was an active member of the influential Bristol Medical Reading Society and in 1856 he was elected as Physician to the Bristol Infirmary the city's older, more influential and rival institution, holding office for a further twenty years. Of his professional zeal there is no doubt:

> 'He spent a great deal of his time at the Infirmary, and liked nothing better than a chat or gossip in the wards or corridors, either about the cases or any local events. He was often seen at the Commercial Rooms, which he frequented from his love of picking up the latest news. He had a peculiarity which many of the students of those days noted; he would never enter a ward (or indeed any room) without using the tail of his coat as a covering to his hand when turning the handle of the door.' [10]

This brief profile is necessary to set in context the events occurring in late 1846 and early 1847 and the early use of ether for surgical anaesthesia at the Bristol General Hospital.

Mr Joseph Goodale Lansdown

In a letter to the *Lancet* dated 11 January 1847, Mr Joseph Goodale Lansdown, Surgeon to the Bristol General Hospital wrote:

> 'I find, from Dr Fairbrother, that he has sent you a letter respecting the operation I performed on the 30th ult, whilst under the influence of ether. I suppose he has described the exhibition of the ether and its results.'[7]

This refers to the mid-thigh amputation performed by him under ether anaesthesia administered by Dr William Herepath. It is left to the reader's judgement as to whether this represents an air of approval or irritation.

Three further procedures under ether anaesthesia are described, namely orchidectomy, resuture of scrotum and resuture of amputation stump in a young boy. No reference is made to the presence of an anaesthetist. However, the method employed was the Herepath bladder which, prior to the orchidectomy, was observed to have an obstructed mouthpiece resulting in failure. The quality of anaesthesia achieved in the other two cases would rate only as analgesia, with oral communication being maintained throughout. This is in sharp contrast to his next case:

> 'Today I removed the right leg of a woman, aged 62. This time Dr Fairbrother used an apparatus constructed under the direction of Dr Boott and Mr Robinson. The time occupied before the ether had taken effect was longer than upon the previous occasions; when it was produced, it was most perfect ... we could not convince the old lady that she had lost her leg. The gentlemen present, to the number of about twenty-five were perfectly astonished.
>
> I remain, Sir, yours respectfully,
>
> J G Lansdown, Surgeon to the Bristol General Hospital.'[7]

In a letter dated the next day, 12 January, Dr Fairbrother wrote to the *Lancet*:

> 'Yesterday, a second operation was performed, at the Bristol General Hospital, upon a female aged sixty-three years. Her leg was amputated by Mr J G Lansdown, the operating surgeon, and completed in less than five minutes. In this case I administered the ether by means of Robinson's apparatus, with the most complete success. It took about eight or ten minutes to procure a state of insensibility ....nor could she believe her leg was removed. During the operation, alternately brandy was given with the inhalation of the ether.
>
> I am, Sir, your obedient servant,
>
> A Fairbrother MD, Senior Physician to the Bristol General Hospital.'

Both accounts are in accord, but clearly an induction time of 8 to 10 minutes, almost double the operating time, exceeded the surgeon's expectations; today it would probably receive less favourable surgical comment. It is apparent that Fairbrother had no involvement with or knowledge of the three surgical cases receiving ether on the two preceding days. However it does seem that he can be credited with presiding over the second case in Bristol to achieve full surgical anaesthesia. It also seems that he did not favour the Herepath inhaler, which he either chose to ignore, or tried and then abandoned.

In contrast, Lansdown spent the remainder of January 1847 obtaining further experience with Herepath's inhaler, using it for a variety of procedures. As far as can be ascertained these were conducted without the presence of another physician or surgeon, at locations outside hospital – either in his or the patient's home. All these made a rapid and uneventful recovery. In a letter to the *Lancet* in February he gave an account of thirty cases.

> 'In the introduction of any novelty in our profession, I consider the best mode of forming a correct judgement of its merits is to procure a collection of unvarnished facts bearing upon the point. This is most particularly applicable with regard to the operations while the patients are under the influence of ether. Since my last letter, I have had frequent opportunitiies of trying its effects and will give the cases according to their several dates. I have now administered the ether thirty times.'[9]

I have made a tabulated summary of these administrations. It is evident that Lansdown's thirty must include the three minor cases already referred to and not overseen by Fairbrother.

The fading of enthusiasm

The recording, in a provincial city, of no less than 32 administrations for a wide variety of conditions all within the first month, is probably unmatched in the annals of early British anaesthesia. At present it is only possible to speculate as to why such apparent enthusiasm for anaesthesia in Bristol seemed to fade away.

Bristol may have been the victim of the general apathy and caution which greeted anaesthesia. Many centres in London were actively against its extensive adoption. The Bristol situation may have been a reflection of local, political and personal factors. Firstly, William Herepath could not reasonably support or promote a process which was largely regarded as

	Anaesthetist			Anaesthesia		
Admins	and Apparatus	Patient	Surgery	Good	Partial	Fail
30	J G Lansdown	Male	Orchidectomy	-	-	1
	SURGEON	Male	Suture Scrotum	1	-	-
	Herepath App	Male Young	Suture Amputation	1	-	-
		Female 12 years	Dental Neuralgia	1	-	-
		Male 60 years	Ca Lip	-	1	-
		Female 26 years	Dental Extraction	1	-	-
		Male 12 years	Attempt Toenail extraction	-	-	1
		Male 12 years	Toenail extraction	1	-	-
		Male 14 years	Dental extraction	1	-	-
		Female 20 years	Dental extraction	1	-	-
		Male 64 years	Urethral Bougies x 19	18	-	1
		Female 15 years	T/K Amputation	-	1	-
1	W B Herepath	Male	Leg Amputation	1	-	-
	CHEMIST					
	Herepath App					
1	A Fairbrother	Female 62 years	Leg Amputation	1	-	-
	PHYSICIAN					
	Robinson App					
Total: 32						

Surgical Cases with Ether Anaesthesia
Bristol, 30 December 1846 to 28 January 1847

experimental, and not at that time widely acclaimed. Secondly, without the support of the medical staff of the city's more important and older hospital, the Bristol Infirmary, any initiatives from Herepath and the Medical School were likely to fail. Finally, Herepath having withdrawn from the more politically divergent hospital following his first and apparently only administration of ether, a vacuum was created at that institution. To Lansdown, the surgeon, would go the credit, if any, for the pioneering of painless surgery with the less satisfactory means of administration, whilst Fairbrother, the physician and less endearing colleague, had the means of promoting a more conventional and reliable technique.

Lansdown saw the anaesthetic process as being merely an adjunct to surgery, entirely within the scope of the surgeon to achieve. Having attempted to perfect the Herepath technique, his recorded cases were undertaken in the home or in his 'consulting room'. They were, in the main, minor procedures and the patients were often described as being responsive to commands and questions. His observations importantly demonstrated how light anaesthesia, or more accurately analgesia, could be appropriate for ambulatory patients – the forerunner of day case surgery as we know it today.

Meanwhile, at Bristol Infirmary, the dawn of anaesthesia failed to occupy the minds or stir the souls of the physicians and surgeons, unless it was simply to be rejected. It would be nearly four years until, on 31 August 1850, the first anaesthetic was administered, for a lithotomy.[11] The surgeon, John Harrison, had been a keen resurrectionist in his earlier days, but was one of few among his fellows who conscientiously undertook his lecturing duties to students. He became Senior Surgeon in 1850 and may thereby have had some influence in persuading his colleagues, some of whom were known to be mesmerists, to agree to general anaesthesia. The six members of the Bristol Infirmary Honorary Surgical Staff - William Francis Morgan, Nathaniel Smith, Henry Clark, Thomas Green, Augustin Prichard and John Harrison - all signed this minute in the consultation book:

> 'Cons. Room, Aug 31 1850. A consultation was held upon Samuel Edgar, a patient with Calculus as to the propriety of administering Chloroform previous to the operation of lithotomy, and it was agreed that chloroform should be administered.'

The 50 year old patient did well, but a further nine months were to elapse before the next administration. This was again to a patient of Mr Harrison, on 20 May 1851.

From this short enquiry, the full explanation for the eclipse of anaesthesia's dawn in Bristol remains unclear. This is a less than satisfactory conclusion for a city which was so prosperous and outgoing and had been the setting for the forthright prediction of surgical anaesthesia by Humphry Davy some fifty years previously. However, at the appointed time, in late 1846, the complexity of having the choice of two techniques – one born out of Davy's researches – and the influential views of men with differing perceptions and character, may have been significant local factors. While advances were being made elsewhere in the country, four years were to elapse before anaesthesia in Bristol would emerge from the darkness.

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WOULD ADVANCED TRAUMA LIFE SUPPORT HAVE SAVED LORD NELSON?

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Portsmouth can be considered the home of the Royal Navy and the town has very close ties with Nelson. It was from here in 1805 that he sailed to what has been described as his finest hour, and to his death, at Trafalgar; here his flagship HMS *Victory* remains.

We all appreciate that lessons can be learned from history and that it is sometimes worthwhile to take a step back and reflect on what advances we have achieved. I thought it would be interesting to speculate on how Nelson may have fared with today's trauma care. Before that, however, we need to know something of the background and about what happened on 21 October 1805. I will briefly paint a picture of what it was like to be a ship's surgeon at the time of Trafalgar and then examine the circumstances surrounding the death of Nelson in what nowadays, from a trauma point of view, could be called his 'Golden Hour'.

HMS *Victory*

The *Victory* as seen today remains impressive and picturesque but remember that she was a warship and was designed to kill people. She was one of the largest ships of the time and was called a first rater, with over 80 guns and 500 crew. The gun decks were incredibly cramped and noisy. By comparison, Wellington with his army 10 years later at Waterloo had only 150 pieces of artillery. During normal duties the sick bay was located in the for'ard area as the importance of hygiene and ventilation had been appreciated by this time. However, during times of action the sick bay was transferred to the lower orlop deck as this was nearer the waterline and therefore offered some protection against further injury from fragmentation. *Victory* had one ship's surgeon who, at Trafalgar, was Mr William Beatty, and two assistant Surgeons, Messrs Smith and Westernburg.

I am sure that no-one would draw parallels with the current situation but during the 18th century physicians were university trained, were considered scholars and gentlemen and their opinions were expensive. Surgeons on the other hand were considered craftsmen, and learned their trade by apprenticeship. Apothecaries were the dispensers but often were taken on as Assistant Surgeons; anaesthetists had not been invented. To become a ship's surgeon the prospective candidate had to have been examined by what was the Company of Surgeons which had split from the Barber-Surgeons Company in 1745.

In 1800 the Royal College of Surgeons of London was formed and took over this rôle. At this time ships' surgeons were not commissioned officers in the Royal Navy and recruitment was a problem, but they were still comparatively well looked after as is shown by the relatively comfortable surgeon's quarters on the *Victory*. Guidelines are nothing new and written instructions were given to ships' surgeons by the Sick and Hurt Board which subsequently became the Board of Transport. The instruments of Mr William Beatty are preserved, including an amputation knife, scalpel, bullet extracting forceps, bone saw, two trephines and a gate tourniquet, and they were all well used. Bearing in mind that Trafalgar was nearly 40 years before the first anaesthetic was given, surgical quality from the patients' point of view consisted of a single attribute - speed. One of the commonest operations was amputation and the average time taken to perform a limb amputation was about four minutes. This was not a mere guillotine procedure but often a more considered technique with skin flaps and ligatures on the appropriate vessels. Nelson had previously had a right above elbow amputation on 25 July 1797, following a grape shot injury during the battle of Tenerife. His worst memory was the shock of the cold knife and he subsequently instructed all ships' surgeons to warm their instruments before use.

It is interesting to note that he was given opium postoperatively and that his surgeon had appreciated the value of early enteral feeding such that the next day he was able to tolerate a light diet. Forty years before the first anaesthetics were given the best a patient could hope for was some rum prior to his surgery. It needs to be borne in mind that injuries sustained in battle were really only a minor cause of death at sea and that disease was far more significant. Although still a problem, the causes of scurvy had been identified by this time, and since 1795 the Admiralty had insisted that lime juice should be issued on all ships as well as rum. As well as the other common infectious diseases of the time foreign travel meant that malaria and yellow fever were also a problem.

The action

In 1805 Britain was still at war with France and naval dominance had prevented Napoleon invading Britain across the Channel. Nelson wished to destroy the Franco-Spanish fleet which he had been chasing for 18 months.

He sailed from Portsmouth in September 1805, again having got word that the enemy was putting to sea. The two fleets first sighted each other at dawn on 21 October but with light winds took about six hours to close. They engaged off Cape Trafalgar. As Nelson wanted complete destruction of the Franco-Spanish fleet he adopted the slightly radical tactic of 'crossing the T'; rather than trading broadsides on a parallel course he attacked in two columns at 90°, aiming to break through and to disrupt the enemy formation. The French guns opened fire at about 11:30 am and *Victory* first fired shortly after noon as she came up behind one of the French ships. Nelson's flagship then found itself in the thick of close quarter battle, with another French ship, the *Redoubtable*, approaching *Victory's* starboard side.

At approximately 13:15 Nelson was hit in the left shoulder by a musket ball fired at a range of about 50 feet from the rigging of the *Redoubtable*. He is quoted as saying: 'They have done for me at last; my backbone is shot through'. He was carried down to the sick bay which was no easy feat, as this was four decks below. There, Mr Beatty was treating about 40 other wounded and dying men. The scene was subsequently described by the Reverend Dr Scott as 'worse than a butcher's shamble'. Mr Beatty assessed Nelson's injury. He noted the entrance wound on the left shoulder, which he gently probed and discovered no metallic foreign body. He also noted that there was no exit wound. Nelson was complaining of 'severe back pain and privation of sense and motion of the inferior extremities'. His pulse was weak and irregular and his respiration short and difficult.

Subsequent examination at post mortem revealed that Nelson had sustained the following injuries:

Entry wound to left shoulder
Fractured acromion process left scapula
Fractured left second and third ribs
Collapsed left lung
Ruptured large branch left pulmonary artery
Fractured left sixth transverse process
Complete transection spinal cord
Fracture right seventh transverse process
Musket ball lodged in right paravertebral muscles about two inches inferior
to lower pole right scapula

The symptoms and signs of hypovolaemic shock were noted over the next one to two hours with Nelson complaining of severe back pain and also that he felt blood gushing within his chest. His chest was rubbed to ease the pain, he was fanned to try and keep him cool and given some cooling drinks of water, lemonade and a little wine. Like today, doctors have to be bearers of bad news and William Beatty concurred with Nelson that nothing could be done for him. About two and a half to three hours after he had been shot Nelson requested his steward to turn him onto his side. This the steward did and Nelson died a few minutes later. Bear in mind that Nelson was far from being the only casualty that day. Especially on the Franco-Spanish side, the numbers of dead and injured were in the thousands. Being Ship's Surgeon in these circumstances must have been hell.

Nelson's body was preserved in a barrel of brandy for the journey back to England and his state funeral. At post mortem a 16.6 mm musket ball was retrieved. It showed deformation of the ball and some of the material from Nelson's left epaulette was still attached to it. It was reputed to have been fired from a type of French musket similar to a Versailles Carbine but ballistic examination shows that it was fired from a pre-French Revolution musket. A gelatine block simulation of the type of projectile that hit Nelson demonstrates a large permanent cavity from direct tissue crush. Modern high velocity bullets cause more tissue damage and crush injury associated with projectile yaw, fragmentation and energy dissipation. Sadly our advances in medicine are often in response to such advances in injuring people.

Modern trauma management for Nelson

If Nelson had sustained similar injuries today would our current expertise have altered the outcome? Figure 1 shows the Admiral back on deck, and he obviously hasn't learnt from the past as he has gone straight to the spot which is right in the sights of the French sharpshooter. History repeats itself and he falls to the deck having again been shot through the left shoulder. Immediate battlefield first aid would probably not be very different today. Hopefully, there would be improved basic airway manoeuvres if required, but essentially the first aid treatment would still consist of stopping the bleeding and applying a tourniquet if appropriate.

However, we have considerably improved communications and transport now so we see that an appropriately equipped medical team has quickly arrived by helicopter. They naturally follow Advanced Trauma Life Support guidelines and simultaneously assess and treat the ABCs with cervical spinal control. This will involve the administration of oxygen, intubation and ventilation followed by needle thoracocentesis and left chest drain placement after establishing intravenous access. The use of pre-hospital fluids in hypovolaemic shock due to penetrating torso injury is an area of interesting debate at the moment. The team will

Figure 1. Modern Management for Nelson?

obviously use appropriate spinal stabilisation and then transport the patient to the right place at the right time, probably again by helicopter. There is likely to be a large welcoming crowd. Major trauma is often an 'all or nothing' phenomenon in terms of the number of people involved. If word gets around that a famous person is being brought in there usually is no shortage of personnel, with everyone looking for knighthoods. William Beatty was knighted some years after Trafalgar - which shows that you do not necessarily have to be successful in your treatment.

In the Trauma Unit a chest x-ray will show the relevant injuries, the musket ball lying just inferior to the right scapula, and correct placement of endotracheal tube and chest drains. Nelson will obviously need a left thoracotomy to stop the bleeding; depending on his state on arrival this will hopefully be done in the operating theatre. There is some data from Houston and San Francisco that shows benefit for emergency room thoracotomy in the moribund patient with penetrating chest trauma although the outcome for stab wounds is obviously better than gun shot wounds. Subsequent care of the Admiral will be in an appropriate Intensive Care Unit. It is easy to overlook one of the most major advances since Trafalgar in that, with the advent of anaesthesia and analgesia, Nelson will have been unaware and pain free since his resuscitation. Finally, he will have been immunised against tetanus and will be given prophylactic antibiotics. But will he survive.....?

Outcome

I think in these optimal circumstances Nelson would have survived although he would obviously have been wheelchair-bound and paraplegic. In which case he would probably have ended up with much brandy inside him rather than the reverse.

The Humphry Davy Lecture

NOT JUST NITROUS OXIDE: THE LIFE OF SIR HUMPHRY DAVY

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All anaesthetists are taught about the early days of their speciality and the name of Sir Humphry Davy has been revered as one who first showed the analgesic effects of nitrous oxide inhalation. His early studies of this gas at the Clifton Pneumatic Institute in Bristol are well described in his notes and books; they cannot be denied. Several writers have regretted his abandonment of medicine when he subsequently moved to London and lasting fame, with his work in chemistry at the Royal Institution and Royal Society. A careful reading of his biographies and personal papers suggest that this simplistic view of his life and work is not totally accurate. Davy ignored or never really understood the significance of his great discovery and the world had to wait another 50 years before Wells and Morton in Massachusetts realised the full potential of their observations on nitrous oxide and ether inhalation. Possibly we are unwise to hallow the name of Davy in relation to anaesthesia. His fame and reputation for original thought may best be left within the field of chemistry.

Early life

Humphry Davy was born on 17 December 1778 in Penzance; a small slate plaque on the doorway of 8 Market Jewry Street still marks the house. He was christened at Madron Parish Church and the record of this is very unusual in that he is written in as the daughter of Robert Davy, 'daughter' then being crossed out and 'son' written above it! One of five children, Humphry was brought up partly on the family estate of Varfell overlooking Mounts Bay and partly by a family friend Mr John Tonkin, surgeon and apothecary. His house stood on the site of the current Mansion House at the top of Market Jewry Street. The young Davy was educated initially at the local primary school in Penzance before moving to the Grammar School in Truro in 1794, the year his father died. He was not a notable scholar and left school at the age of 17 to be apprenticed to Mr John Bingham Borlase, surgeon apothecary and later physician in Penzance. His shop is just opposite Davy's birthplace and is currently showing an extensive window display referring to Davy.

During this time Davy became a keen fisherman and an expert shot. He revelled in the countryside around Penzance and he started to write poetry mainly about the scenery and weather conditions that he experienced every day. He was a loner, seemingly more content with his own company than that of others and an avid reader who suddenly appears to have developed an interest in chemistry and built a small laboratory in Tonkin's attic. Whilst still pursuing his basic desire to become a physician he took to scientific chemical research with enormous enthusiasm. He wrote an essay '*On heat, light and combinations of light*' that was published by Beddoes in Bristol in 1798. This was a very sophisticated theory on oxygenation of blood and electricity and light which although completely wrong and a source of considerable embarrassment to Davy in later life, was nevertheless a remarkable piece of work for a relatively self-educated young man. He was introduced by chance to Davies Giddy, one of the new young 'intelligentsia' who had moved to the new 'in place' to live - Clifton and Hotwells around the spa waters of Bristol. In addition, Gregory Watt came to convalesce in Penzance and moved into the Davy household thus acting as a further intellectual stimulus for the young scientist.

His investigative work at this time was varied and by today's standards unusual. He analysed the composition of air in seaweed bladders and looked at the effects of sea-water on the iron and copper floodgates fitted to harbour defences. His apparatus was self-made and piecemeal and yet the young scientist became 'noticed'. When Beddoes was searching for a Superintendent for his planned Pneumatic Institution, Davy's name was suggested. In early October of 1798 Davy travelled up to Bristol to start work with Beddoes on this new project. Davy's previous friend and mentor, John Tonkin, was most upset by this turn of events. He cut Davy from his will and effectively severed contact with him.

The Pneumatic Institute

In Bristol the 19 year old Davy was suddenly plunged into a totally alien environment. Here was a centre of medical and artistic excellence and eccentricity where charlatans, gifted scientists and artists mixed freely. The 'new' hot spa attracted the gullible, the sick and 'high society'. The sophisticated lifestyle must have been fascinating to an impressionable 'country boy'. Here he was to meet and mix with Wordsworth and Southey; Roget, Clayfield, Sadler, Giddy and Edgeworth; Erasmus Darwin, Wedgwood, Tobin, Cottle, Coleridge and Godwin all pre-eminent in their fields and all destined for greatness.

When Davy first arrived in Hotwells the Pneumatic Institute in Dowry Square was not yet open and so he started to work from Beddoes' house further up the hill in Rodney Place. The laboratory opened in March of 1799 and by the next month some 80 outpatients were being seen on a regular basis at the Institute. Davy had read Dr Samuel Latham Mitchill's theory of contagion published in March 1798 and this led him to further investigate the effects of the inhalation of nitrous oxide.

Davy's work with nitrous oxide has been reported many, many times. His personal experience of the relief of severe toothache and his prophetic words on the possible use of the gas in surgery have been cited by scores of anaesthetic historians. His book '*On nitrous oxide*' published in 1799 failed to get the message across to those searching for a method to alleviate surgical pain. Davy himself seems not to have realised the potential of his discovery and those of his friends and colleagues who inhaled the drug seemed to do so for personal pleasure rather than serious scientific investigation or the future benefit of others. There can be no doubt that Davy stumbled by accident on a potential anaesthetic and sadly failed to capitalise on it or really realise what he had. It is the more astounding since he was surrounded by the so-called 'romantic poets' who frequently intellectualised on the importance of helping humanity and relieving suffering. They all just seem to have overlooked that which they had.

In July 1800 Davy started to perform investigations on galvanism and by October was able to show that zinc oxides contaminated by water could be made to liberate oxygen while pure oxides would not. He was a literally fearless experimenter, willing to breathe almost any volatile substance and was lucky to survive breathing hydrocarbonate gas which he noted had the ability to destroy life. He was also able to comment on the effects of asphyxia describing the implications of 'black blood' circulating to the brain after the rescue of a drowning soldier. His enthusiasm to breathe almost any substance and his long hours of work in the laboratory started to take a toll on Davy's health and he was forced to go home to his mother in Cornwall for a month to recuperate. During this time he collected samples of air from a variety of places and having analysed them was able to show that their composition was uniform.

Humphry seemed to thrive in his new world and started to travel to meet other scientists. He visited Gregory Watt in Birmingham, and in December 1799 went up to London for the first time. Here he stayed with Coleridge, Southey, Watt and Underwood and was naturally captivated by the even greater world that London must have seemed to him at that time. The young scientist must have made an impression. When late in 1800 Count Rumford began to look for someone to take on the development of the Royal Institution, Davy appeared to be a suitable appointment. He was invited to be Director of the Laboratory and Assistant Professor of Chemistry in February 1801. With the blessing of Beddoes, whose Institute was not developing particularly well after initial interest and which was doomed to close in the near future, Davy moved to London.

Royal Institution

The Royal Institution had evolved out of the *Society for Bettering the Conditions of the Poor*, set up in 1796. Situated in Albemarle Street (where it still remains) the Institution housed amongst its facilities a large laboratory, a library and two lecture theatres to which the general public was invited to be 'educated'. Count Rumford, the current President, was slightly surprised by Davy whom he thought to be of a 'rather odd appearance'. Davy now aged 22 must have found the change in his circumstances to be quite extreme. As he started to give a course of lectures based on his scientific thoughts and experiments, he was thrown into a social world that was even more challenging for a quiet man whose favourite sport was fishing. At one dinner he stated that he found the poetry of Milton rather difficult to understand only to receive the comment from another guest: 'very likely, very likely sir, but I am sure that is not Milton's fault'!! These were singularly harsh words considering Davy himself was regarded by many of the great poets of that era to be equal in stature to themselves. Southey wrote at a later date that: 'If Davy had not been the first chemist, he would have been the first poet of his age'.

Davy obviously coped with these social challenges and his career at the Institution rapidly advanced. His lectures proved so popular that within a short time he was 'promoted' from the small to the large theatre. He was appointed a full Lecturer in June of 1801 and gave a series of lectures on the science of tanning. Later that year he devised a galvanic battery with charcoal electrodes instead of metal ones. His January 1802 Introductory Discourse was a huge success and immediately propelled him into the highest society of London where he was feted by scientists, literary figures and socialites alike. By May of that year he had been appointed Professor of Chemistry. Other writers have drawn interesting analogies with his work in chemistry and that of his close friend William Wordsworth in poetry. Professor Roger Sharrock has suggested that:

> 'Both are trying to prove that a subject previously considered to be exclusively specialised is in reality a primary concern of all intelligent and sensitive men. Both declare that their subject bears a direct relation to human progress'.

Davy himself certainly believed that the study of chemistry was in no way divorced from aesthetic satisfaction, one was an integral part of the other.

Davy was, however, considerably out of step on the political front after the horrors of the French Revolution. He and many of his literary friends were staunch republicans. Davy joined the Tepidarian Society which met in Old Slaughter's Coffee House in St Martin's Lane and promoted their republican beliefs and spoke highly of Napoleon at every opportunity. This did not go down too well at a time when England was at war with France.

His work at the Institution meanwhile continued, seemingly in almost every field of science. Progressing with galvanism, he made a huge battery with some 500 plates each of 5 inches diameter. He developed the work of Wedgwood who had impregnated silver nitrate into leather and adapted a solar microscope to make copies of small objects on this medium; the main problem being that they had to kept in the dark. He arranged for the East India Company to import a species of mimosa called catechu that could be used for tanning and proudly wore a pair of shoes made by this process. In 1804 he arranged to buy a plot of land near Roehampton for agricultural research and in 1806 he reported a series of geological experiments. By 1807 he had become Editor of the *Philosophical Transactions*, regarded as the most important scientific journal of its time. He described the laws of voltaic electricity and was awarded, by the Institute of France, Napoleon's Prize of 3000 Francs for the best work on galvanic fluid. It was noted that while the two countries were at war, science was not. He distilled pure potassium, sodium and chlorine as well as producing pure strontium and boron. He continued to travel when he could; he gave a series of lectures to the Dublin Society and was awarded an Honorary LLD by Trinity College Dublin. In April 1812, the Prince Regent conferred on him a knighthood.

Marriage

In 1811 the by now hugely successful Davy had fallen in love with a rich widow, Mrs Apreece. This lady, a relative of Walter Scott, was the centre of a literary coterie in Edinburgh. She was extremely wealthy but was not of a robust health. Their marriage was notoriously unhappy. Humphry's brother summed up her character:

> 'She was a remarkable woman with many faults and many redeeming qualities but taken as a whole fitted to excite admiration rather than love; and neither by nature happy in herself or qualified to impart happiness to others'.

However, the marriage gave Davy total freedom from concerns about money and undoubtedly changed the direction of his life completely. This was to be the end of his first major chemical researches although he published *Elements of Chemical Philosophy* in 1812 and *Elements of Agricultural Chemistry* a year later. In 1813 he resigned as Professor of Chemistry at the Royal Institution and went on an extended European tour with his wife and Michael Faraday, who had recently joined him as an assistant.

Europe

England was still at war with France when Davy's party landed in Brittany and they were immediately arrested. Their journey had however been sanctioned by Napoleon and once the correct papers had been procured from Paris their trip proceeded. He was feted on his arrival in the French capital by the likes of Ampere and Gay-Lussac and was elected to the Imperial Institute. He visited the Louvre, had an audience with the Empress Josephine and managed within a short time to offend almost the whole of Parisian Society with his studied indifference to all that he was shown together with his flippant and supercilious attitude. Here was a very different man from the darling of London Society that he had been at the beginning of the century. Money and status together with an unhappy marriage were changing Davy. He travelled to Montpellier and then to Genoa, Rome and Pompeii. Having toured Switzerland he returned to London in 1815 to meet his next major challenge.

Safety Lamp

The coal mines in Britain at this time were death traps for the miners with their candle lights. 'Firedamp' caused many explosions, while the asphyxiating 'afterdamp' or 'stythe' threatened all those in poorly ventilated shafts. Following the deaths of 92 at Felling Colliery near Sunderland in May 1812, a Society for Preventing Accidents in Coal Mines was set up. In 1815, the Chairman of this group, a Dr Gray, wrote to Davy who was shooting in the Borders and asked him to help. Davy arranged for a sample of firedamp to be sent to London and in October of that year wrote to Gray with four possible methods of safe lighting. These were a safety lamp, a blowing lamp, a charcoal lamp and a piston lamp.

The simplest and most ingenious of these was his safety lamp. By the application of his knowledge of heat and light Davy created a lamp surrounded by a fine platinum wire coil. Firedamp would put out the flame and yet an explosion would not occur because it could not pass through the coil of metal. The platinum became white hot and would re-light the lamp when it came in contact with air again. This Safety Lamp was introduced immediately and grateful colliery owners in Northumberland collected together a sum of £1500 and presented Davy with a 30 piece gold dinner service. He never took any money from this invention, but received many awards world wide including the Rumford Medal from the Royal Society in 1817 and a silver vase from the Emperor Alexander of Russia in 1825.

Later life

Davy was made a Baronet in October of 1818 . He toured Europe once more visiting Naples, Cologne, Vienna and Rome. At each city he busied himself with different investigations; in Rome it was the elucidation of why mists appear around rivers and in Herculaneum he attempted unsuccessfully to unroll papyri. On his return to London he was elected President of the Royal Society in 1820, and he here began a further period of research and publication. He wrote and lectured on electromagnetism, he tried to stop algae growing on ships by covering them with copper and then turning the copper positive with the use of tin, zinc and lead plates. His assistant Faraday liquefied chlorine gas for the first time and Davy enhanced and promoted this work.

He continued to visit his mother in Cornwall on a regular basis although he never took his wife with him on these visits. He tried to buy his old house in Penzance but the local Corporation for some reason blocked the purchase. He was given a public dinner in a large hotel in Penzance in 1821 which seems to contradict the stories of lack of popularity at home.

Back in London he was a founding member of the Athenaeum Club and started another new venture with the creation of London Zoo. His old friend from East India Company days, Sir Stamford Raffles, became Chairman of the Friends of a proposed Zoological Society. A document in February of 1825:

> 'proposed to establish a society bearing the same relations to Zoology and animal life that the Horticultural Society bears to botany and the vegetable kingdom. The object is to attempt the introduction of new races of quadrupeds, birds or fishes etc. applicable to purposes of utility either in our farmyards, gardens, woods waters, lakes or rivers; and to connect with this object a general zoological collection of preserved specimens'.

The following month they had resolved to create a collection of living animals belonging to the Society to be established in the vicinity of the metropolis. With the backing of the then Home Secretary, Robert Peel, Davy applied to the Government for ground in Regents Park. In April of 1826 they were leased 5 acres and the zoo was established with the provision of a Griffin vulture and a white headed eagle together with a Malaysian female deer. The zoo opened to the public in late April 1828.

From 1825 onwards Davy's health began to decline. He was too tired to attend the celebratory dinner to mark his election as President of the Royal Society. In 1826 he suffered an apoplectic fit which was treated by copious bleeding. He was partially paralysed but made a slow recovery. His mother died in September of 1826 and this was a terrible blow to the sickly Davy. They had always been very close and with a lifeless marriage Davy had little to fall back on emotionally. He spent that winter in Italy and then resigned from the Royal Society partially on health grounds in 1827.

Davy who had been an ardent fisherman all his life, and a great admirer of Walton, spent the majority of that year finishing his epic tome on fly fishing entitled *Salmonia*. This he personally illustrated and the book describes a series of conversations between two ardent fishermen and two interested others. In March of 1828 he wrote a paper on Vesuvius and volcanoes in general and then completed what was to be his last book: *Consolations in Travel or the Last Days of a Philosopher*. He moved to Rome and was living in the Via di Pietra off the Corso when he had another stroke. Lady Davy left London to join her husband and was in Rome within 12 days, his brother John who was a military physician came to Rome from Malta and the three resolved to travel to Geneva. Humphry Davy died in that city on 29 May 1829 and was buried in the cemetery at Plain-Palais just outside the city walls.

His grave in Geneva is marked by a splendid marble stone, now in need of considerable restoration. There is a tablet to Davy in Westminster Abbey erected by his wife. The people of Penzance collected money for a statue of Lamorna granite depicting Davy with his lamp, which was erected in Market Jewry Street in October 1872 . His books and papers survive in archives in the Royal Society and Royal Institution in London, and the Morrab Library in Penzance has an interesting collection of memorabilia. His £1500 solid gold dinner service was melted down and the gold used to award the Davy Medal for the most important discovery in Chemistry, the first such award going to Bunsen and Kirchoff in 1877. His lamps and inventions can be found in museums the length and breadth of the country. There are roads named after him in Bristol and a Public House in Penzance and there are literally dozens of biographies.

Conclusions

Davy was a great chemist, a brilliant, innovative researcher but a poor record keeper, and an undoubtedly unconventional scientist. He was a gifted poet, a philanthropist who aided the poor and those in danger and took no money for this work. He was the creator of a famous zoo and a long lasting London Club. He was the recipient of a myriad of honours in his lifetime and ever since. He was a radical politically and in later life a rich dilettante who had the ability to offend greatly those who wished to laud him. He was a loner most of his life, more at home with male company than female. He never had children and seemed more comfortable with maternal than wifely love. His baptismal record adds a further strangeness to all this.

Does he deserve great recognition from anaesthesia and anaesthetists? I believe not. He made a great discovery, recorded it, showed it to colleagues, failed completely to realise its potential and forgot about it. His use of nitrous oxide was more for recreational gain than humanitarian benefit. My view is that we should leave Davy with his chemical fame and stop trying to apply his name to things associated with our speciality. He was a great man but no friend to anaesthesia.

Acknowledgements

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JOHN SNOW'S *CASE BOOKS 1848-1858*

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From the outset, John Snow (1813 -1858) appreciated that for the safe and consistent application of anaesthetics, the scientific principles of their administration had to be established. His endeavours in this respect made him the greatest pioneer of British anaesthesia. Within 14 months of the news of anaesthesia arriving in London, he began his *Case Books*. They record his day to day anaesthetic and general practice activities until his sudden death in 1858. These sole surviving manuscripts are housed at the Royal College of Physicians of London. Their poor condition had prevented general access, but this situation has now changed, thanks to the meticulous transcription of all three volumes of Snow's difficult script by the late Dr Richard Ellis. His monumental efforts have given the ordinary anaesthetist a 'window in time' through which to peer and marvel at the exploits of John Snow.[1]

John Snow

Born the son of a manual labourer in York, John Snow rose to become pre-eminent in at least two medical fields (anaesthesia and epidemiology) and to attend upon his Sovereign, Queen Victoria. Despite these humble origins, his parents evidently strove to educate their children to the best of their ability. At the age of 14 he was apprenticed to a surgeon in Newcastle-upon-Tyne, there witnessing the cholera epidemic of 1831 and the opening of the medical school. At 20, he became an assistant in general practice in Yorkshire until, in 1836, he travelled to London to further his career at the Hunterian School of Medicine. In 1838, aged 25, he qualified and set up practice at 54 Frith Street, Soho. He was a diligent and inquisitive practitioner, obtaining further higher qualifications, and regularly attending meetings of the Westminster Medical Society and the Medical Society of London (later becoming president of both). In 1846, aged 35 years, this quiet, teetotal, modest bachelor with a zest for medicine, reached a crossroads in his career.

Snow had a case report on the 'strangulation of the ileum in an aperture of mesentery' published in the 18 December 1846 edition of the *London Medical Gazette*.[2] This same edition broke the news of anaesthesia from Boston in an article entitled 'Animal magnetism superseded - discovery of new hypnopoietic'.[3] It was perhaps whilst scanning this journal his attention was drawn to the advent of anaesthesia. On 28 December, Snow arranged a visit to witness ether anaesthesia for himself, at James Robinson's dental practice nearby in Gower Street.[4] Snow very soon designed a reliable inhaler and established sound principles for the administration of anaesthesia. He was a gifted and ingenious researcher, formulating anaesthetic concepts far ahead of his time. His reputation as an anaesthetist rapidly spread and his services were soon in demand by the most eminent surgeons and dentists of London.

The *Case Books*

The three *Case Books* are retrospective accounts of his cases from the preceding day(s), recorded as some 7,000 entries. They served as an essential resource for his concurrent publications on anaesthesia.[5-8] As his anaesthetic practice evolved, his general practice list, to which he was dedicated, diminished. Abruptly, in May 1853, he removed his succinct general practice case entries to the back of the *Case Books*. To the present day anaesthetic researcher these entries are a distraction, and possibly Snow found them so as well!

His anaesthetic practice included operating sessions at the major London teaching hospitals. He also anaesthetised in a wide variety of other locations including private residences, hotels, lodgings, and at many local hospitals. Anaesthesia was provided for surgical, dental and obstetric patients, and for a spectrum of medical conditions including asthma, neuralgia, insomnia, tetanus and cholera. Some of the hospitals have since changed their names. The Hospital for Consumption, for instance, is now the Brompton; others, such as the Hospital for Decayed Gentlewomen have ceased to exist altogether. He appears never to have anaesthetised patients at his own residence. In November 1848, he travelled to Weston-super-Mare, to administer to a young lady with an infected maxilla whose 'insanity' prevented her journeying to London. In July 1856, he went with Mr William Fergusson (who was later to become President of the Royal College of Surgeons) to the tiny village of Hartherop, Gloucestershire, to operate upon a vicar's rectal sinuses (another condition that presumably prevented travelling). By this time both were eminent practitioners, so what obligation or inducement there could have been for their travelling to a tiny remote village north of Swindon remains a mystery.

The predominant anaesthetic agent Snow employed was chloroform. He rightly regarded chloroform as potent and potentially unsafe unless the inhaled concentration could be carefully regulated. In 1848 he described his temperature compensated, wicked, low resistance, draw-over portable chloroform inhaler,[5] with a consistent maximum 5% inspired chloroform-air mixture. He had only one death from chloroform in over 4200 cases. Rarely, other agents were used, mainly ether and Dutch Liquid. In June/July 1851 he received samples of Chlorurretted Chloride of Ethyle and Chlorated Muriatic Ether from Paris and employed them with success. Snow's quest for the perfect anaesthetic led him to introduce amylene into clinical practice from December 1856. He abandoned amylene after 234 cases following his second death with this agent on 30 July 1857. He reported this case frankly and with conscientious speed, published as it was in the *Medical Times and Gazette* of 8 August. A delay of just 9 days in getting an important case report into print and thus accessible to the anaesthetic community at large is impressive by modern standards.

His patients spanned all ranges of age and social standing, and the surgical complexity of some would challenge the skills of the bravest and best-equipped modern anaesthetist. At least one item of interest, often of fascination, can be found on almost every page of the *Case Books*. For example:

- When on Christmas Day 1850 a 3 day old baby is found unconscious having ingested by 'mistake' Dovers Powder (containing opium), who was called? John Snow, an authority on neonatal resuscitation.
- The 7 year old child from Bristol being operated on by Mr Fergusson for a hare-lip, when the surgeon had to dash home in the middle of the operation for his cutting pliers.
- The infantry Captain returning from the Crimean war to have a bullet 'and a portion of his drawers' removed from his lower leg.

- The Earl of Uxbridge had sat alongside Wellington on the evening of the Battle of Waterloo (1815) with the French troops routed, when a cannon ball struck him. He is reputed to have calmly said 'I've lost my leg, by God.' Thirty five years later, aged 82, this same 1st Marquess of Anglesey was plagued by neuralgia from the stump. Snow treated him by applying chloroform firstly to the stump itself (to no effect other than a little redness), and then by repeatedly anaesthetising him. During recovery from these anaesthetics he would consistently give a speech 'as if addressing the Board of Ordnance or a dinner party'.

- Snow's most famous patient was Queen Victoria. Less is known of a Lady in Waiting to the Queen, the Hon Miss Kerr, who had a single tooth extracted in January 1853, 3 months before the Queen's first experience with chloroform. Did this tooth need extracting or was she sent to 'test the waters' and report back? Snow administered chloroform during the births of Prince Leopold in April 1853 and Princess Beatrice in April 1857. On the latter occasion he arrived to find Prince Albert having already applied the chloroform with a handkerchief. Each time, after Snow had attended Buckingham Palace, he went on to fulfil other commitments and anaesthetise other patients the same day. Connor & Connor,[9] have used the *Case Books* to demonstrate that, contrary to popular belief, this Royal patronage of obstetric analgesia did not have a dramatic impact on its application to the wider population. In fact the events were very sparsely reported in the medical, let alone the lay, press. Snow himself, respectful of confidentiality and demonstrating his own modesty, never publicised his Royal involvement.

John Snow is also celebrated for his pioneering epidemiological work on the spread of cholera. In 1849, an epidemic of cholera in London killed more than 7,500 people. John Snow deduced that transmission was by contaminated water and not foul air, and published his conclusion.[10] However, it was not until a second epidemic of 1854, when 89 users of the Broad Street water pump in Soho died in the first week of September, that Snow was able to convince his critics.[11] This detective work would certainly have taken considerable time and effort. He studied the General Registers of Deaths, interviewed relatives and doctors of the deceased, visited the local coffee-shops and public houses and the commercial premises in the locality. Demands on Snow's anaesthetic services as the 'Queen's Anaesthetist' would surely have precluded the time for these investigations. Analysis of the *Case Books* shows that consistently, over the 8 complete years covered, Snow conducted very few anaesthetics during the month of September, and 1854 was no exception (Figure1). The principal surgeons at Kings College Hospital who utilised Snow's services the most - Messrs Fergusson, Bowman and Partridge - never operated in September. Did they go on vacation? If so, John Snow certainly did not, and with time on his hands he did a great service to epidemiology.

Looking at the raw numbers of anaesthetics Snow performed each year (Figure 2), it can be seen that his anaesthetic practice increased only gradually over the decade from the introduction of anaesthesia until his untimely death. One can safely assume that if anyone was anaesthetising during this period, it would have been John Snow. This would suggest that the establishment of surgical anaesthesia in London (or the expansion in surgical practice) took time. Indeed, the use of anaesthesia for major operations was by no means universal during the Crimean War (1854-1856) or the American Civil War (1861-1865).[12]

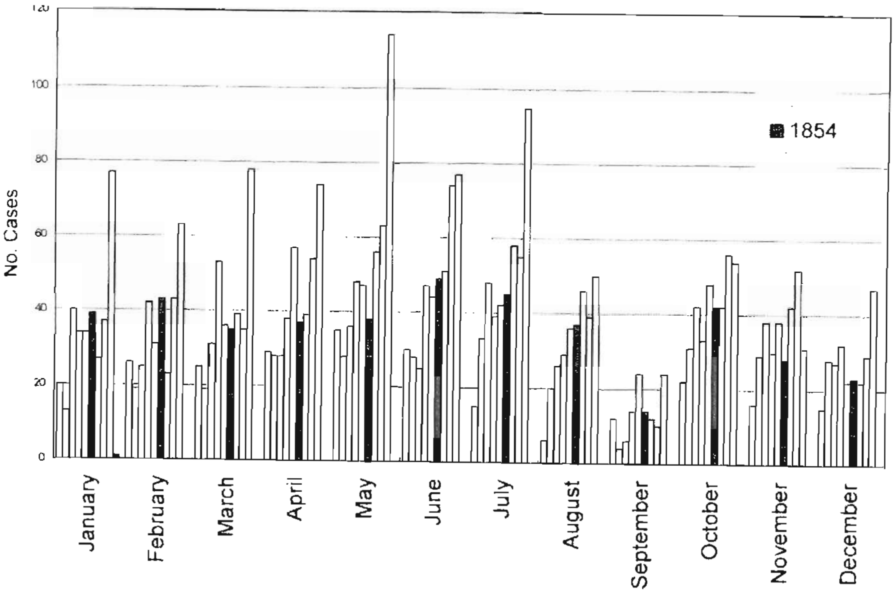

Figure 1. The anaesthetic cases of John Snow for each month 1849-1857

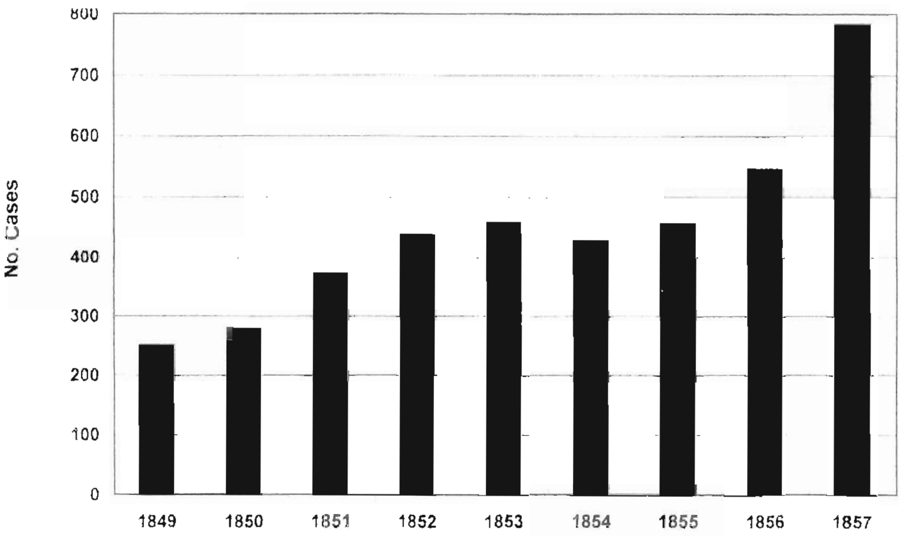

Figure 2. The anaesthetic cases of John Snow; total numbers 1849-1857

Four days after his last entry in the *Case Books*, John Snow suffered an incapacitating stroke, and he was dead seven days later. He is buried in Brompton Cemetery. The marble tombstone was erected in 1858 *'by his professional brethren and friends'* and reads: *'In remembrance of his great labours in medicine and of the excellence of his private life and character'*. The tombstone was restored by his friend Sir Benjamin Ward Richardson in 1895, but then lay untended and deteriorating. It was to be the combined efforts of Professor Ralph Waters, Sir Robert Macintosh and Sir Ivan Magill which resulted in the raising of a subscription to restore the burial site of one of the most outstanding anaesthetists.[13] The base now reads *'Inscription restored in 1938 by members of the Section of Anaesthetics of the Royal Society of Medicine and Anaesthetists in the United States of America'*. His grave was further restored in 1950 following damage incurred during the London blitz.[14,15]

Since then, the importance of Snow's contributions has become widely recognised. We owe a great debt to the work of Dr Richard Ellis who has given present and future generations of anaesthetists ready access to a priceless historical resource - *The Case Books of John Snow*.

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MACINTOSH AND THE SPANISH CONNECTION

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Professor Robert Macintosh frequently visited Spain, where he had good friends, and he had an important influence on the development of anaesthesia in our country. In this paper we offer information about the relationship of Macintosh with Spain and the reasons for his important role in the development of Spanish anaesthesia.

First visit

Macintosh came to Spain for the first time in September 1937, during the Spanish Civil War (1936-1939), to assist the American surgeon Joseph Eastman Sheehan (1885-1951) with his plastic surgery operations for the many casualties with severe face wounds. Sheehan had come in 1928 at the behest of King Alfonso XIII to treat patients in the Military Hospital of Madrid suffering from the sequelae of wounds received in the war against Morocco.[1] He was decorated by Alfonso XIII and he made numerous influential friends in Spanish society (including the royal family, the Duque de Alba and Dr Gómez-Ulla). The Duque de Alba lived in England during the Spanish Civil War, and was the unofficial ambassador of General Franco in that country. It is conceivable that the meeting of Sheehan and the Duque with Macintosh, and their request that he go to Spain, took place at the Huntercombe Golf Club.[2] Mr Chilton, the British ambassador in Spain, also played an important role in Macintosh's first visit.

Macintosh spent six weeks in the Hospital General Mola in San Sebastián, in the rearguard of the national side, anaesthetising for Sheehan's reconstructive operations on facial injuries. In 1938 Kenneth Boston took his place. During Macintosh's time there several Spanish physicians worked with him, including Dr Soler Roig (from Barcelona), Dr Carmelo Balda (from San Sebastián) and Dr Sánchez Galindo (from Madrid). They were fascinated by Macintosh's anaesthetic skills, especially his use of the Flagg's Can and endotracheal intubation.

Before leaving Spain in the spring of 1938, Sheehan visited General Franco in Salamanca, and urged him to maintain the plastic surgery unit at San Sebastián[2]. Franco's response was to send the military surgeon Sánchez Galindo to the USA to receive instruction under Sheehan's patronage. He spent eight months in several surgical clinics, where he learned both surgical techniques and the basics of modern anaesthesia[3]. On returning to Spain, he headed the Plastic Surgery Unit of San Sebastián, where he applied the anaesthetic techniques he was taught in America and those he had learned with Macintosh, using ether with endotracheal intubation. After the war he returned to the Gómez Ulla Military Hospital in Madrid. There in the 1940s he treated a number of patients with sequelae of injuries suffered during the Civil War, and also many soldiers of the Spanish Blue Division who were injured fighting against Russia during the Second World War. In his papers he always wrote that he used the original technique of Macintosh[3] and we consider that Dr Sánchez Galindo was the first Spanish disciple of Prof Macintosh. During Macintosh's first stay in Spain, Dr Soler Roig of

* Presented by Dr Diz

Barcelona was appointed as his assistant, since he spoke fluent English (he was a personal friend of the surgeon, Lawrence Abel and the anaesthetist, Ronald Jarman). Macintosh could speak Spanish perfectly, with a strong South American accent, which he had learnt in Argentina where he had lived with his family. However, he always spoke English in the weeks he spent in Spain in 1937, and Soler Roig did not know that Macintosh could speak Spanish. He was therefore surprised when several years later, in 1946, they met in the airport at Barcelona and Macintosh greeted him in perfect Spanish. Although he inquired of Macintosh, the Englishman did not offer an explanation for his behaviour on the first visit.[4] Soler Roig had learned several techniques with Jarman in London including endotracheal intubation, the use or rectal Avertin and intravenous Evipan. He administered anaesthesia during the war, but instead of the Flagg's Can, he used the oilcan of a Singer sewing machine for giving ether (personal communication, 1992). He did not practice anaesthesia after the war, when he returned to work as a surgeon in Barcelona, but he had the assistance of some of the first Spanish specialists in anaesthesiology.

Post war visit

After the Second World War, Macintosh travelled widely, visiting departments of anaesthesia and lecturing in many countries. One of his first postwar journeys (if not the first) was to Spain in 1946, at the invitation of the Spanish High Council of Scientific Research. This Council was created in 1939 to promote and coordinate research in Spain. Macintosh visited Barcelona and Madrid (September-November 1946), where he gave demonstrations in several hospitals, lectured on new trends in anaesthesia and introduced the Oxford Vaporizer. In Barcelona his host was Soler Roig. Macintosh administered anaesthesia and gave lectures in several Barcelona hospitals including Santa Cruz y San Pablo Hospital (today named Santa Creu i San Pau, in Catalan), the School of Medicine, Sagrado Corazón Hospital, the Neurological Institute of Barcelona and several private clinics. He used thiopentone, curare and ether with the Oxford Vaporizer. Probably his best-remembered lecture was on the *State of the Art of Anaesthesia.*

In Madrid he gave demonstrations in the Cancer Institute, Provincial Hospital and a few others. He used thiopentone or ethyl chloride for induction and sometimes cocaine for spraying the larynx, then intubation. Maintenance or deepening the anaesthesia was with ether via the Oxford vaporizer and he did not use curare in Madrid. Here his most important lecture was titled *The Improvement of Anaesthesia*, and given in the School of Medicine. Besides the scientific aspect of these visits there was a financial reason, since Macintosh wanted to introduce the Oxford vaporizer into Spain. Although there were several of these inhalers in Spain (and later a few EMOs), the economic situation was precarious after the Civil War, and it was impossible for many clinics to afford them.

These visits had two important consequences for Spanish anaesthesia. First, there was wide publicity, and many Spanish anaesthetists were fascinated with this British specialist, who used very modern techniques which were quite unusual in Spain in those years, and who was Professor at one of the most renowned universities in the world. Thus the work of the Nuffield Department came to be considered synonymous with the most advanced anaesthesia. Second, during his stay in Barcelona, Macintosh met Dr José Miguel Martínez, Head of the Department of Anaesthesia of Santa Cruz y San Pablo Hospital.[4]

Oxford as the Mecca of Spanish anaesthetists

After Macintosh's visit to Madrid and Barcelona in 1946, the Nuffield Department became the most important centre of anaesthesia for Spanish anaesthetists and it remained so until the 1950s. Those who wanted to reach the highest level in anaesthesia had to go there. Many visited Oxford, Drs Montón, Vela, Elio and Balboa (Figure 1) among others, but only a few stayed for a prolonged period in the Department. To our knowledge, only Dr María Oliveras (1910-) from Barcelona completed the courses in anaesthesia, in 1948.[5] She spent eight months in the Radcliffe Infirmary, and two months in a paediatric clinic in London. Later, Dr Eduardo Reixa also completed the courses[5]. Although most Spanish visitors stayed for only a brief period, they were very proud to describe themselves as disciples of Prof Macintosh, and to have a photograph with Macintosh in Oxford was an important item in the curriculum.

Macintosh and Dr José Miguel

Dr. José Miguel Martínez (1905-1998) was a physician who began his training in anaesthesia before the Spanish Civil War, and in 1939 decided to work exclusively as an anaesthesiologist. In 1941 he was appointed Head of the Department of Anaesthesia in Santa Cruz y San Pablo Hospital, in Barcelona. He organized many courses on anaesthesia, and in 1946 published a textbook[6] which was widely used throughout Spain. His book had chapters

Figure 1.
Prof Macintosh and Dr José Maria Balboa on a liner in the port of Vigo (c 1960).
Courtesy of J L Balboa

on endotracheal intubation, epidural anaesthesia, rectal anaesthesia, the use of barbiturates, and descriptions of several anaesthesia machines, some designed by himself. He met Macintosh for the first time in 1946, and Macintosh sold Miguel an Oxford vaporizer, curare, endotracheal tubes and several flasks of Avertin (personal communication). Macintosh was surprised by the high level of anaesthesia practised by Miguel, particularly because of the isolation of Spain in those years, and because Miguel had not visited other countries. His main criticism was the poor quality of the inhalers being used. Miguel had initially worked with the Ombredanne. He progressively introduced modifications to this inhaler, including the use of oxygen and valves, but the equipment was still very crude, and did not allow the precise administration of ether. Having used the Oxford vaporizer, Miguel decided to build a new inhaler, based on his previous modifications of the Ombredanne and some improvements he found in the Oxford. In 1948 he published a description of this new inhaler, which he designated OMO (Oxford, Miguel, Ombredanne) (Figure 2).[7]

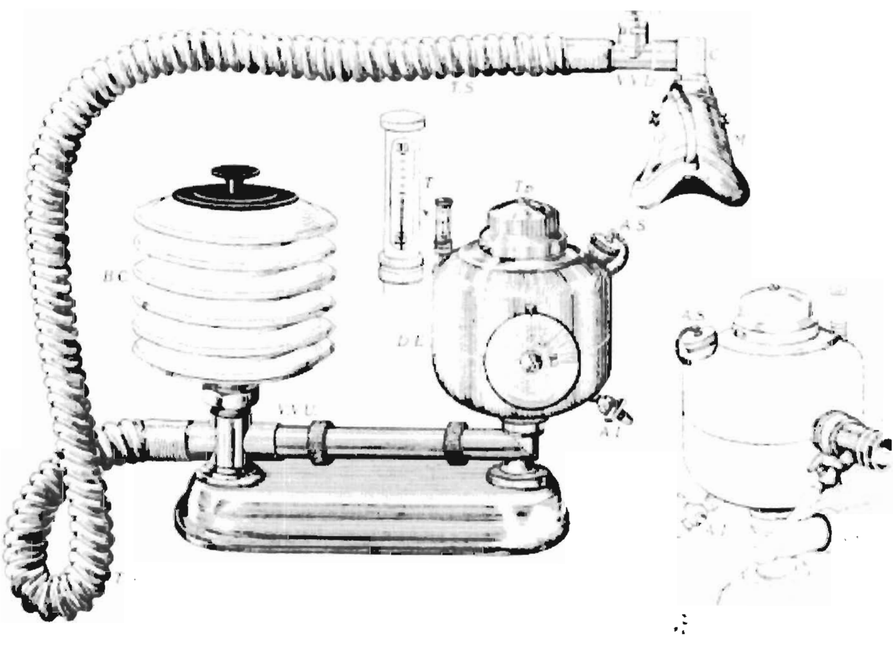

Figure 2.
The OMO inhaler (Oxford, Miguel, Ombredanne)[7]

In his paper he acknowledged the influence of the Oxford vaporizer, and he noted that the main reason for producing the OMO was the economic climate of Spain after the war, which made it very difficult to import vaporizers. The inhaler was still rather crude, but it proved a real improvement in the equipment of the Spanish anaesthesiologists. It was significantly cheaper than the foreign inhalers and it allowed a better control of etherisation than the Ombredanne. Some two thousand OMO inhalers were sold in Spain.

Miguel and Macintosh became good friends and in subsequent years they met often in Spain. In 1951 they were at the Congress of the Spanish Society of Surgery in Madrid. During a visit to El Prado Museum, Macintosh asked to see the statue of the Greek god Hypnos.[4] Miguel and the other anaesthesiologists were surprised (and ashamed), since they did not know that the statue was in Madrid. In 1953, the statue became part of the emblem of the Association of Anesthesiology of Catalonia, and of the journal *Hypnos*, the anaesthesia supplement of *Anales de Medicina*.

In 1953 the first Congress of the Spanish Society of Anesthesiology was held in Granada. Macintosh joined Miguel in Barcelona, and they went to Granada by car with their wives. Macintosh was to give the main lecture of the Congress on *The Viewpoint of a British Anesthesiologist*. He was to speak in Spanish, but had brought his script in English. Miguel and other Spanish anesthesiologists spent all the night in the Hotel Alhambra translating the lecture (personal communication). Macintosh visited Barcelona again in 1961, invited by the Academy of Medical Sciences of Barcelona and the Association of Anesthesiology of which Miguel was the Chairman. He gave a lecture entitled *The Instruction of the Anaesthetist* and he was appointed an Honorary Member of the Academy. In a personal communication of September 1988, Miguel said: '... recently Macintosh has been five or six times to Barcelona, and we have met at Congresses and Meetings in Granada, Málaga, Sevilla, Valencia .... we are close friends'. In many ways, Miguel was the most important disciple of Macintosh in Spain. Although he had learned anaesthesia before, the relationship with Macintosh allowed him to improve some of his techniques. Probably the most significant result was the influence of Macintosh and his Oxford vaporizer in the development of the OMO anaesthesia machine.

Macintosh visited Spain on many other occasions. To our knowledge, he never visited Santiago, but he was once in the nearby city of Vigo. During the 1950s and 60s liners coming from South America and other countries would call at the port of Vigo before continuing to other destinations in Spain or Europe. In the early 1960s Macintosh was a passenger on such a liner which stopped in the port. He went to the General Hospital of Vigo (then named Residencia Almirante Vierna, and the city's biggest hospital), and introduced himself to Dr Pazo, Head of the Department of Anaesthesia (personal communication). Dr Pazo and his staff were very surprised that the famous Professor Macintosh wanted to visit their Department and spend the day with them. This unexpected visit to a peripheral department was typical of Robert Macintosh's lifelong interest in Spanish anaesthesia.

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WHY WAS NITROUS OXIDE-OXYGEN ANAESTHESIA NOT DISCOVERED IN CLIFTON IN THE YEAR 1800?

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To answer this question it is necessary to review the various factors in the Industrial Revolution impacting on the health of the British working population whose numbers doubled between 1700 and 1800.

Industrial revolution

The first of these was the creation of a ready source of capital for the expansion of commerce by the formation of the Bank of England and a Permanent National Debt.[1] This sprang from the fertile brains of the Scot, William Paterson, and Charles Montagu, the Chancellor of the Exchequer, and led to a new way of government borrowing on long term loans. Under this system patriotic investors did well for themselves and their country by leaving their money on long term deposit earning a good interest secured by the State as part of a Permanent National Debt. The principal lenders to the government were, in 1694, organized into the Bank of England to which the Government ministers gave the support of public credit in its banking operations with individuals. This provided a ready source of capital to expand manufacturing, or to enable the Lord of the Manor to buy out his individual farmhands' manorial strip holdings so that he could participate in the revolution then occurring in British agriculture.

Another factor was the earlier creation of the largest Free Trade zone in Europe when Scotland and England were united in 1603. This opened the English job market to a large body of well-educated, entrepreneurially minded and energetic Scottish Nonconformists. Not being members of the Church of England hindered their participation in politics and government. So they devoted their energies to developing the new industries particularly iron smelting, using capital made available by the new banking system.[2] In agriculture the inefficient manorial system with each family farming a strip of land in each field was gradually phased out. The resultant large fields were enclosed by fences and the land could be farmed much more efficiently. The output was greatly increased but many farmhands were displaced from the land.[2] At the same time farming machinery such as threshing machines, the horse-drawn hoe and the seed drill designed by Jethro Tull were being introduced and replacing more farmhands. King George III was a leader in introducing the new farming methods on his model farm in Windsor. Improved strains of cattle and sheep were also being introduced.[3]

With the increased food supply, the disappearance of the formerly endemic plague, the reduction of 'ague and fever' with the draining of the land and with improved hygiene and medical care of mothers and infants, the population of Britain increased from 7.5 million to over 14 million in the 60 years of the reign of George III from 1760 to 1820.[2] This was many more than could be supported by the old manorial system, but the more efficient agricultural methods resulted in more farmhands losing their livelihood and desperately seeking work.

Up to this time the manufacture of textiles was a small scale cottage industry.[4] Joseph Priestley's father, for example, was a weaver. The inventive genius of a group of north country craftsmen resolved the unemployment crisis by mechanising and greatly expanding the textile industry, relocating it into mills able to provide the destitute farmhands with work in the newly industrialised towns.[3] Amongst these inventive craftsmen[4] were John Kay of Bury whose flying shuttle in 1733 more than doubled a weaver's output besides improving its quality, and James Hargreaves of Blackburn, whose spinning jenny in 1764 increased the weavers' output eightfold. The traditional spinners, resenting this improved efficiency, broke into Hargreaves' home and destroyed his frame. He moved to Nottingham where he established a spinning mill.

Richard Arkwright of Bolton in 1768 set up his first spinning frame in Preston. This was the first machine able to produce cotton thread strong enough to be used as the warp in weaving. The spinners in their cottages were outraged, seeing in this new machinery a challenge to their lifestyle. To escape the mob raging against all machinery, Arkwright also moved to Nottingham where he established his first mill which was driven by horse power. Three years later, in 1771 he set up a larger mill driven by water power at Cromford in Derbyshire.[5] He patented each improvement to his machinery but legal disputes arose when rival cotton spinners pirated his designs. This led to popular animosity being stirred up against him on the grounds that his inventions were diminishing the demand for labour (in fact, at its peak in 1914 the cotton industry employed a half million workers). In 1779 the mob destroyed his largest mill in Chorley in the presence of a police and military force .

When James Watt and Mathew Boulton's rotary steam engine[5] became available in 1781 it eliminated the need to site mills on a source of water in the hills. The steam engine vastly increased the demand for coal; mining, which had been a family business employing the wives and children[3] expanded greatly, increasing the numbers of workers exposed to the awful working and living conditions.

To transport the coal from the mines on his estates to the mills in Manchester, the Duke of Bridgewater in 1761 dug the first of the many canals that were to follow. It then became essential to locate mills along the canals and they thus became clustered together in new industrial towns. To save space, housing for the workers was built crowded around the mills, often resulting in living conditions which spread respiratory infection (Figure 1). Watt's rotary steam engines further polluted the atmosphere in these congested towns by the smoke belching forth from the mills' coal-fired furnaces.[5] Some inkling of what those conditions must have been like was given by the catastrophic smog which enveloped London for several days in autumn 1952. During that week over 5,000 more elderly patients with chronic respiratory and cardiac conditions died than would have been expected.

Arkwright was knighted in 1780, and in 1790 he introduced the first steam engine in his Nottingham mill, thus completing the evolution of the power sources used in the cotton industry. When the depletion of British timber forests led to a fuel famine leaving the hearths in many homes cold, the situation was saved by a new canal system which brought coal to domestic hearths and to the iron smelting furnaces of the English midlands which soon became known as the Black Country. The former agricultural workers may have found employment in the 'dark satanic mills' but they had exchanged the clear country air for heavy atmospheric pollution and grossly overcrowded housing (Figure 2).

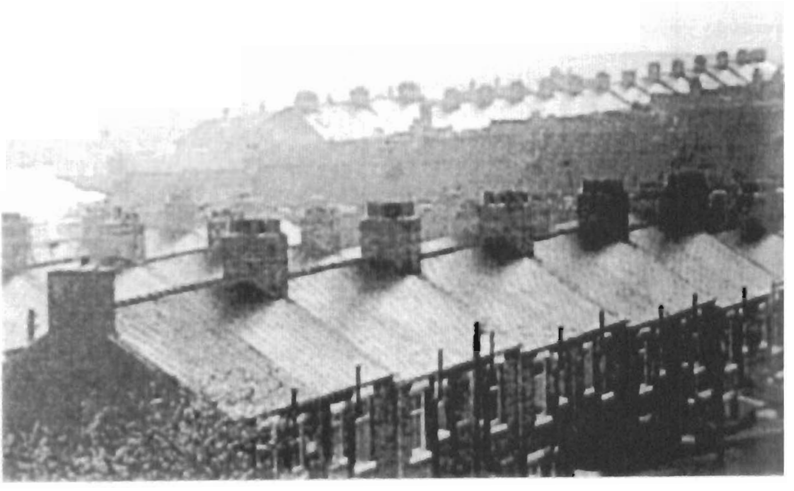

Figure 1. Back-to-back housing[5]

Figure 2. Victorian slum[5]

Respiratory diseases

The widespread chronic bronchitis, pulmonary tuberculosis and other lung infections presented physicians with an urgent need to find anything that could relieve these respiratory problems. Joseph Priestley who had introduced nitrous oxide in 1772 and oxygen in 1774, in 1780 went to live in Birmingham. He was welcomed by Boulton and Watt to contribute to the scientific discussions of their Lunar Society, so called because it met, often in Boulton's home, at the time of the full moon, to assist members returning home after their meetings. [See *HAS Proceedings* Vol **14**, 9-12. Ed.]

To support Priestley's research the members, who included Wedgwood the potter and Darwin, the father of the author of *On the Origin of the Species*, provided him with a stipend of £100 per annum.[6] Beddoes and other physician participants were eager to determine the role of these gases in the function of the lungs and their possible value in treating respiratory problems. Beddoes, with the support of 189 subscribers, including 44 physicians and 19 surgeons, in 1799 founded the Pneumatic Medical Institution in Clifton. It was here that he and Humphry Davy carried out their studies with the personal participation of many well known writers and poets who widely publicised the pleasure and exhilaration they experienced on breathing nitrous oxide. This gave these studies an embarrassing party-like reputation.

In his 1800 report on *Researches Chemical and Physiological, Chiefly Concerning Nitrous Oxide*, Davy reported on its potent analgesic effects and suggested its possible use in surgery. However, lacking evidence of any positive pulmonary therapeutic effects neither Beddoes nor Davy were interested in pursuing these studies any further.

The missed opportunity

Unfortunately there were no dentists involved in the Institute's studies who might have taken up Davy's suggestion, for their practice frequently inflicted pain on their patients. Anything which could have avoided pain would have been a sure practice-builder. As Smith[7] has pointed out, Watt had already designed what was a rudimentary anaesthetic apparatus. The use of oxygen with nitrous oxide had been tried and the greater safety of this had been appreciated. With the simple addition of connections for nitrous oxide and oxygen and a bag and mask (Figure 3) the Clayfield's[10] apparatus could have been used to determine the optimum concentration of nitrous oxide and oxygen for anaesthesia in just the way Frederick W Hewitt used his similar apparatus of 1899.[11] What was lacking was the incentive to relieve pain, which it was felt was intended to be endured: witness the religious opposition to Simpson's introduction of chloroform analgesia in labour.

The exhilarating effects noted in Davy's studies led to its use as 'laughing gas' by popular scientific lecturers. It was the astute observation of its potent analgesic action by Horace Wells, the Hartford, Connecticut dentist at such a lecture that led to him receiving, on 11 December 1844, the first nitrous oxide anaesthetic[9] although in the popular poem recounting 'Dr. Syntax's Visit to Paris' in 1820 the use of nitrous oxide in Paris to relieve the pain of dental extractions was mentioned.[7]

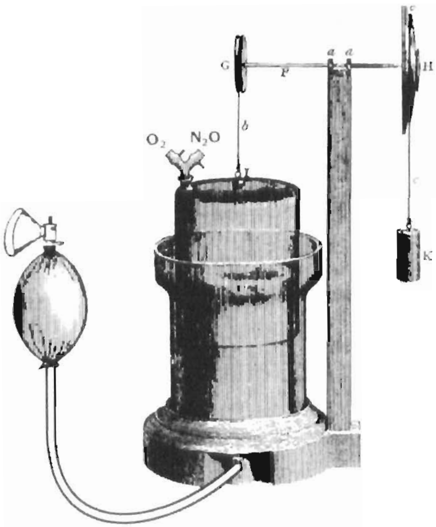

Figure 3.

The anaesthesia machine Davy could have produced

Had there been the British equivalent of Horace Wells practicing dentistry in Clifton in 1800 the 63 years' delay in the introduction of nitrous oxide anaesthesia might have been eliminated. We might today be celebrating the foundation of the CLIFTON Dental Association surgeries in British cities rather than the opening of COLTON Dental Association offices across the USA in 1863.

Conclusion

The brief answer to the question posed in my title is therefore twofold - in the Britain of 1800 the prevalence of pollution-induced chest diseases monopolised the physicians' attention, and no one at that time was seeking to eliminate pain.

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Guest Lecture

BRISTOL AND THE SLAVE TRADE

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Honorary Tutor, University of Bristol

Origins of the trade

The origins of the African slave trade that flourished during the 18th century lie with the discovery of America by Christopher Columbus in 1492. The Spanish who went out to colonise the new lands had no wish to work like peasants, but to be gentlemen, and for this they needed a workforce. At first they tried to enslave the native population, but the people died of cruelty, neglect and disease. Next they imported criminals from their own country, and when these people were unable to stand the climate and harsh conditions, the plantation owners looked for another source. The Portuguese had trading connections with the coastal areas of North West Africa, and they were able to buy from the tribal chieftains African slaves who would previously have been sold to Arab traders for sale in the Middle East.

In 1562 Sir John Hawkins carried out the first slaving voyage to Africa by an Englishman. With Spain and Portugal pre-eminent in South and Central America, the other European nations were determined to carve out their own settlements in the new lands. The British were in the West Indian Islands and the southern states of North America; Bristol people particularly settled in Virginia. The English were also determined that the lucrative African slave trade should be shared between all nations, not just Spain and Portugal. Eventually England, France, Germany, the Netherlands and Scandinavia would all send out trading ships to the African coast – at first, to trade for gold, ivory, hardwoods and exotic animal skins, but later for slaves.

In London the first trading company to deal with Africa was set up 1631, and called the Africa Company. They would set up fortified trading posts and sanction strictly controlled trade voyages. In 1660 the society was refounded as the Royal Africa Company and given a formal charter by Charles II. The premise was still that all trade with Africa should be done through this one federation of merchants; it was illegal for any ship from any other port, and not sanctioned by the Company, to trade with Africa. In spite of this, all evidence points to Bristol breaking this law. In the meanwhile the Bristol Members of Parliament, supported by those from other maritime cities and the colonists of the West Indies and North America (who desperately needed constant and plentiful supplies of slaves), lobbied furiously to get the monopoly of the Royal Africa Company lifted. This finally came about in 1698, when the slave trade was opened to all British ships.

Bristol joins the trade

Bristol at once joined in the trade with North West Africa. Ships left Bristol laden with trade goods, such as cotton cloth, glass beads, alcohol and guns. Metal was a most popular trade item, particularly copper, brass and iron goods (like pots, pans or kettles) and metal in rods. These could be shipped in the form of crude, torque-shaped ingots called Manillas or Manilloes. The ships also carried items that could either be traded for slaves in Africa or shipped on to the colonies and sold; these included such things as clothing, building materials (including roof tiles), writing materials and carpets.

When a Bristol ship arrived in Africa, it moored offshore near a settlement with a fort or stockade. The local agent, acting on behalf of the merchants who had chartered the ship, was hopefully ready with a consignment of slaves. The climate was so unhealthy that the aim was always to have a cargo waiting, which could be loaded and allow the ship to leave as soon as possible. Even at the height of the slave trade, there was still a constant demand for gold, ivory and hardwood as well as people.

The leg of the journey known as the Middle Passage took the slaves from Africa across the Atlantic. This voyage could, in good weather, take about 3 months. During that time, if it were possible, the slaves were allowed up on deck, usually hung with netting to prevent them jumping into the sea to escape the horrors they were suffering. They could be given a hot meal, cooked in vast kettles, and allowed exercise; the area below decks could be cleaned, the 'necessary tubs' into which everyone relieved themselves, could be emptied and any dead bodies could be thrown over the side. However, if the weather were bad, the voyage could take 9 months or more. The crew would be unable to allow the slaves on deck; they would remain below, in foul, stinking, cramped spaces, with little food, uncooked, usually rotten, unemptied tubs and the dead chained to the living, sometimes for weeks on end. Not unsurprisingly, the worst killer was not the brutality of the sailors, but disease – dysentery must have killed millions of Africans and thousands of sailors.

Once the slaves had been sold in the West Indies or in North America, the profits were used to buy the local produce. This included ginger, indigo, timber (particularly mahogany), cotton, tobacco and sugar, molasses and rum. It was the sale of these commodities back in England that made so many merchants very rich. In Bristol the influx of wealth signalled a building boom. Queens Square near the dockside was an early development, followed by a series of town houses in areas like Great George Street (where the house of John Pinney, a plantation owner on the Island of Nevis in the West Indies, and now owned by the City Council, has been restored and can be visited), and mansions in Clifton, typified by Clifton Hill House, now owned by the University of Bristol. The merchants also gave lavishly to public building works – a Library and Theatre in King Street, Assembly Rooms in Clifton, an Exchange in Corn Street.

The coming of abolition

In 1787 Thomas Clarkson, the foremost abolitionist, came to Bristol. Using the Seven Stars public house in Thomas Street as a base and its landlord as his guide, he visited many dockside pubs, including the famous Llandogger Trow, and learned all about the slave trade from the sailors involved. The horrors he uncovered formed the basis of a report he presented to Parliament, and helped to fuel a national movement against the slave trade. He reasoned that most people knew little about Africa – they probably didn't know where Africa was and had never seen an African. Instead, he concentrated on awakening their concern for the British sailors, and through them, for the slaves themselves.

However, too many merchants who were also MPs and local government officials opposed the ending of the trade, and it was not until 1806 that it was finally abolished. This was partly due to public opinion, partly due to financial difficulties amongst British merchants and West Indian plantation owners, to an end of preferred trading conditions with the West Indies, a shortage of sailors, a shortage of slaves, problems with insurance, and the American War of Independence (which closed off the American markets for years). Once the trade was abolished, it was only a matter of time before emancipation could be achieved, and in August 1834 slavery was abolished in all British colonies. £20,000,000 was earmarked to compensate the owners for the loss of their 'property'; nothing was provided for the slaves themselves.

Estimates of the total number of Africans transported from their native land to the Americas by English ships vary wildly, from 2 million to 20 million. The probable number is between 7 and 10 million. From known records, Bristol ships were responsible for carrying in excess of half a million of these people. The true numbers will never be known, and the horror will never be forgotten.

List of Overseas Anaesthesia Societies - Apology

The list on page 66 of Vol 24 was taken from the list of national Societies compiled by Prof Mauve in *Episodes from the History of the Establishment of the World Federation of Societies of Anaesthesiologists*, Nederlands Tijdschrift voor Anesthesiologie 1992; **5**: Supplement 1, 84-86. ISSN 0921-8769.

The Hon Editor regrets that this acknowledgement was inadvertently omitted.

Abstracts

A DAVY BICENTENNIAL REDISCOVERY
Long's Improved Apparatus for Administering Anaesthetic Gases

Dr G S Bause
Honorary Curator, Wood Library-Museum of Anesthesiology, USA

The Wood Library-Museum of Anesthesiology is proud to announce at the Davy Bicentennial Meeting its acquisition of 'Long's Improved Apparatus for Administering Anaesthetic Gases'. This machine has survived the ravages of chloroform commissions, wall-supply nitrous oxide, a hospital fire and about 80 years of careless storage. Would Davy have recognised any of James Watt's engineering behind this apparatus, which was manufactured nearly a century after his experiments with nitrous oxide?

Amos M Long of Monroe, Michigan was awarded US Patent No 294,479 on 4 March 1884 for his *Apparatus for Administering Anaesthetic Gases*. His invention (Figure 1) consisted of a wet cistern, a floating gas chamber moving vertically within that cistern, a compressed gas cylinder casing, a vaporiser and a breathing tube and mask. Features included a floating partition, packing, weights and seating, and detachable, open-bottomed floats.

The A M Long apparatus purchased by the Wood Library-Museum is traumatised but easily recognisable, with remarkable preservation of its original decorative finish (Figure 2). It is the earliest true anaesthesia machine in the Museum and will be fully described in a future publication.

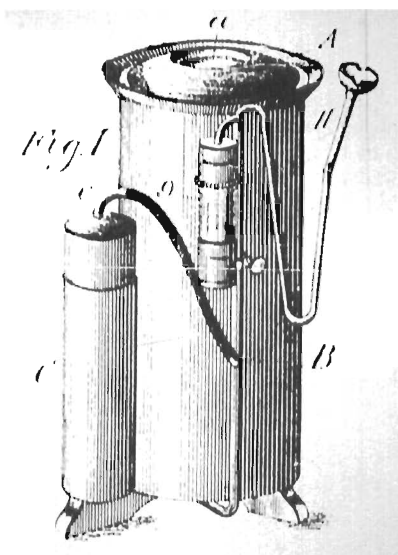

Figure 1

Figure 2

CURRENT THOUGHTS ON ADVANCED TRAUMA LIFE SUPPORT (ATLS) TRAINING.

Mr W B Campbell, Dr J S Heal, Dr S J Evans, Mrs S Marriott
Royal Devon and Exeter Hospital.

There has been recent debate about the relevance and cost of ATLS training, with specific reference to anaesthetic trainees in the United Kingdom. This study sought the views of both anaesthetic and surgical trainees.

Structured questionnaires were sent to trainees in two teaching and two district general hospitals. The response rate was 66%. Of the 184 questionnaires returned, trainees in anaesthesia provided 82, orthopaedics 42, general surgery 26, accident and emergency 26, and other posts 8.

Seventy-seven percent of respondents had done an ATLS course; 83% of the total respondents considered ATLS a 'major advantage' or 'essential' for their proposed career specialty, as follows:

Major advantage or essential

	A&E	**Anaesthesia**	**General Surgery**	**Orthopaedics**
n	18	85	25	40
For practising specialty	100%	75%	93%	94%
For curriculum vitae	94%	49%	50%	83%

Over 90% of the total had a positive attitude towards ATLS, and 74% selected 'genuine improvement of management of trauma patients' as the most important reason for doing the course. Ninety-three percent thought ATLS saved lives. The rigid structure of ATLS was considered generally desirable by 89% (but 73% saw disadvantages to this). Forty-eight percent judged the course 'too American'.

Eighty-three percent thought that all existing consultants dealing with trauma should have done ATLS, and 41% thought it offered major advantages to doctors not involved in trauma. The four yearly reverification interval was considered 'about right' by 73%. Funding problems for ATLS courses had been experienced by 14%. Only four trainees thought they could manage trauma well enough without ATLS. These four were all career anaesthetists.

ATLS instructor status was regarded as a valuable curriculum vitae adjunct by 52% of those in general surgery, by 72% of the orthopaedic trainees and by 77% of those training for a career in anaesthesia.

SPREADING THE MESSAGE

Professor C Prys-Roberts
Sir Humphry Davy Department of Anaesthesia, University of Bristol

This fascinating presentation, using postage stamps to illustrate how the news of anaesthesia was spread, will be published at a later date. (Ed)

TWIN LABOURERS AND HEIRS OF THE SAME HOPES: HUMPHRY DAVY AND ROMANTIC POETS

Dr Catherine E Ross
University of Texas at Tyler

We are accustomed to thinking of scientists and poets as intrinsically opposite or antagonistic beings and support for this notion is often drawn from statements uttered by Romantic poets. It was Wordsworth, for example, who coined the phrase 'we murder to dissect'. This paper claims, however, that certain Romantic people of science and letters should, more properly, be considered as siblings. My research shows that Humphry Davy and his friends, William Wordsworth and Samuel Taylor Coleridge for example, were educated in the same liberal and unspecialised traditions of classical rhetoric; enjoyed many of the same activities and acquaintances; addressed the same polymathic audience; and, more surprisingly, shared many of the same goals and methods in their work. They were, to cite Wordsworth again: 'Twin Labourers and Heirs of the Same Hopes'. Moreover, the British public understood them as such.

The twinship and public perception, along with growing interest in natural philosophy and Davy's astonishing popularity, discomforted Wordsworth in particular, whose *Preface to Lyrical Ballads* is considered the original manifesto of Romantic literary values. Wordsworth seems to have believed Davy's project, which not only touted pleasures and promises of science for public good, but also convincingly displayed the passionate, personal power of the scientist, infringed upon the poets' professional jurisdiction. Consequently, Wordsworth tried to distance himself from his double in science, claiming in his manifesto that the Poet is more truly philanthropic and useful to society than the Man of Science, for he 'defends, upholds, and preserves human nature' and 'binds together by passion and knowledge the vast empire of human society'. Wordsworth was also moved to announce contentiously that poetry is 'the breath and finer spirit of all knowledge; ... the impassioned expression which is in the countenance of all Science'.

From these sentiments and the ways they ramified through romantic literary practice from 1802 onward, I conclude that Davy and the era's so-called 'invention of modern science' was at least as important to the shaping of the profession of Romantic letters as the more usually cited cultural contexts such as neoclassicism, the French Revolution, the German idealism, industrialisation, or the sister arts of painting and print-making.

MY FAMOUS FORBEAR - SIR JAMES YOUNG SIMPSON

Dr T Simpson
Registrar in Anaesthesia, Bristol

James Simpson was born the seventh son to David Simpson in Bathgate Scotland in 1811. His eldest brother was Thomas Simpson whose grandson moved south to Buckinghamshire in 1887 where he set up a successful farming business. He was my great grandfather.

Sir James Young Simpson popularised the use of anaesthesia especially in obstetric practice in the 19th century. In January 1847 he was the first to use ether anaesthesia in obstetric practice. However, he continued to search for an alternative agent that would act more quickly, cause less coughing on induction and less nausea afterwards.

He inhaled a number of hazardous chemicals in his quest such as benzene, acetone and even iodine. After talking to many professorial colleagues, and in particular David Waldie, a friend from medical school who had become an apothecary in Liverpool, Simpson and his colleagues inhaled chloroform on 4 November 1847. They were rendered unconscious and Simpson immediately realised he had found his alternative. By 20 November Simpson had described its use in over 50 patients in a communication to the *Lancet.*

Simpson did not discover chloroform and may not have been the first to use it as an anaesthetic. In the summer of 1847 chloric ether was administered unsuccessfully in London by Dr Michael Furnell,[1] its failure probably due to a weak and impure preparation being used. However, Simpson was undoubtedly responsible for its popularisation and the relief of suffering for thousands of patients, especially women in childbirth.

His most difficult problem was overcoming the prejudices of the church and in particular the established members of the medical profession. His staunch and vociferous campaign for the use of anaesthesia in childbirth had been won prior to the much publicised use of chloroform by Queen Victoria at the birth of her ninth child in April 1853.[2]

Simpson died of heart failure in May 1870, a wealthy and famous man. Reports vary but there were between 10,000 and 80,000 people lining the streets of Edinburgh at his funeral. He has been credited with many achievements but undoubtedly he will always be remembered for his role in the development of anaesthesia and especially chloroform.

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ETHER - AN AGENT FOR TODAY?

Dr I H Wilson
Consultant Anaesthetist, Royal Devon and Exeter Hospital

Due to economic conditions and a lack of development in anaesthesia many patients in developing countries are anaesthetised in less than ideal conditions. Many hospitals are severely short of basic drugs and equipment, including oxygen and intravenous fluids. Ketamine, halothane and diethyl ether are all commonly used anaesthetics.

Ether is administered by Boyle's bottle, EMO or by open drop technique. The lack of cardiovascular and respiratory depression are appreciated, as is the wide safety margin in inexperienced hands. Its disadvantages of flammability, smell, irritant vapour, slow induction and high incidence of nausea and vomiting have made ether unattractive to many anaesthetists and obsolete in the United Kingdom. However, due to deteriorating healthcare systems and economies, it is likely to remain a useful agent for many years for anaesthetists working in difficult circumstances. Indeed, there are many people worldwide for whom an ether anaesthetic would represent luxury.

The reference list below may be of benefit to those who find themselves in a situation where ether is of more than 'historical interest only'.

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OTHER PRESENTATIONS

A feature of this combined meeting was the variety of additional high quality presentations.

VIDEO: ***The Life and Times of Enid Johnson (Macleod)***
Interview by Charles Hope, Professor & Chairman, Dept of Anaesthesia
Dalhousie University, Nova Scotia.
Editor: Richard Bodman*
Video VHS-PAL. Approx 30 minutes.

On 23 January 1942 Enid Johnson gave the anaesthetic when Harold Griffith first administered curare for a surgical operation. She was at that time Anaesthetic Resident at the Homeopathic Hospital, now called the Queen Elizabeth Hospital, in Montreal. After completing only 25 operations using curare they submitted their landmark paper, which was published in *Anesthesiology* 1942; **3**: 418-420.

On completing her training, she married Innes Macleod and accompanied him to Sydney, Nova Scotia. She established an anaesthetic practice but her proposal to use curare met with incredulity and hostility from the local surgeons. Later she returned to Dalhousie Medical School in Halifax and joined the Department of Physiology. She retired in 1976, was named Professor Emeritus in 1978 and received an honorary LLD degree from Dalhousie in 1985.

* Loan copies of this video are available for the cost of postage only, from Prof R Bodman, 2 Riverview Terrace, Glenbrook, Cork, Ireland.

POSTER PRESENTATIONS:

Development of nitrous oxide- oxygen apparatus and their breathing systems
Prof L Rendell Baker and Dr James A Meyer, Loma Linda, USA.
By arrangement with the Wood Library-Museum of Anesthesiology

Heraldry and anaesthesiology
Dr Orestes Meliccio, Tolosa la Plata, Argentina

The Society of Dutch Chemists. Its contribution to anaesthesia
Dr R J Defalque and Mr A J Wright, Birmingham, Alabama

EXHIBITION:

Humphry Davy Retrospect. Biographical works, memorabilia, photographs and paintings.
Dr J A Bennett, Hon Curator, Monica Britton Exhibition Hall of Medical History, Bristol

ENTERTAINMENT:

From Jeremy Jones to the Pirates of Penzance: Laughing Gas on stage and in song.
Dr David Lai, Harvard Medical School.
A sight and sound presentation to the Conference Banquet in the Great Hall, Wills University Building

BOOK REVIEW

Thomas B Boulton, ***The Association of Anaesthetists of Great Britain and Ireland 1932-1992 and the Development of the Speciality of Anaesthesia. Sixty Years of Progress and Achievement in the Context of Scientific, Political and Social Change.*** London, Association of Anaesthetists of Great Britain and Ireland, 1999. Pp. xx + 786. ISBN 0 9536639 0 6.

It scarcely needs me to tell anaesthetists that they are probably the most historically active medical speciality group. This is not simply a British phenomenon. In the United States, anaesthesiologists are at the forefront of the medical profession in historical research. Surgeons, who one might have thought would be very busy in the history of their subject, are, by and large, only active as individuals and do not seem to have the same gregarious impulse as their anaesthetist colleagues. Why anaesthetists are more interested in the history of their own subject than other specialists has always puzzled me. Certainly their work surrounds them with eponymous reminders of their past. I am currently glancing at Minnitt and Gillies' *Text Book of Anaesthetics* of 1948 where the index reveals numerous noteworthy names in anaesthesia appended to pieces of technology: Mennell's modified Junker bottle, Boyle's apparatus, Magill's tubes, McKesson's face piece, Langton Hewer's cardiac puncture needle, to name but a few. This, however, cannot be the complete answer since we might readily point to apparent surgical analogues, Moynihan's forceps etc. Nonetheless, vapour and gas delivering technology are the objects of the anaesthetist's attention in a way that instruments are not the surgeon's focus. History, of course, was coeval with the discovery of anaesthesia, the huge literature of the early priority disputes nearly all focused on tracing the history of the first use, the first suggested use, the first effective use etc. (a history of histories of anaesthesia would make a very good read). But there must be broader reasons for the strong, present day historical attention and the appearance of Tom Boulton's new book provides a clue. Highly developed historical consciousness is of course a mark of traditional conservative elites (the aristocracy are the obvious example) but it can be present, too, in recently arrived, formerly marginal, groups (how many histories of Manchester United are currently on the bookshop shelves?).

Strong historical consciousness among anaesthetists today must in some way be connected to their discipline's relatively recent meteoric rise to prominence within the medical profession. Tom Boulton's impressive new book is the story of one aspect of this rise. The massive 786 pages gathered here cover almost every conceivable aspect of the activities of the Association of Anaesthetists. Founded in 1932 by Henry W Featherstone, the Association has played a key role in the political, professional, intellectual, and technological development of the speciality. The great bulk of Boulton's book covers the post-war years and indeed more than half of it covers the period since around 1970. A recitation of the topics covered by Boulton would be far too long for this review but he is comprehensive, whether dealing with matters professional, educational or social. So often books like this are ruined or at least rendered useless by the absence of references. Boulton has been exemplary in his methodical footnoting. Save for an undue preference for exclamation marks, Boulton writes well and to the point. Anaesthetists may wish to read the book at a single sitting (or multiple more like) although the many topics covered means that the narrative strand gets weaker towards the end where lists of booklets, medal winners and staff etc. take precedence over a storyline. This only gives the work more value as a work of reference. This use will be enormously facilitated by its detailed name and subject indices.

In the early part of the book there is a well-sustained narrative and for me, as an historian, this part raised some of the most fascinating issues. It is usual to trace the history of interest in specialisation in medicine to George Rosen's monograph on ophthalmology of 1944. Until recently few historians, with the notable exception of Rosemary Stephens, have taken up Rosen's baton. In the last few years however, specialisation, along with twentieth-century medical history in general, has very much appeared on the professional agenda, and for this reason alone, Tom Boulton's book is very timely since it provides us with another case study of speciality formation. I am currently working on the rise of clinical biochemistry in the inter-war years and, not surprisingly, I found material in the early chapters of the book that makes for fascinating comparison.

Writing without hindsight is a formidable challenge and in the case of the history of anaesthesia, virtually impossible. No-one in the inter-war years could possibly have foreseen the growth and transformation of the discipline in the latter part of the twentieth century. That the inter-war mentality was different from our own is beautifully exemplified by the fact that Featherstone and a few others did not favour the designation Association but wanted the new body to be called a Guild or Craft. In this they were surely modelling themselves on certain surgeons (Lord Moynihan is a good example) who valued craft skills and although by no means opposed to laboratory science in principle, they did think that bodies like the MRC spent too much money on basic science and not enough on cultivating clinical research based on experience. Such attitudes were often coupled with a distaste for specialism as rather ungentlemanly. It is significant in this respect that Featherstone had sufficient private family income to practise as and how he pleased. His was not, I guess, a professional scientific model of medicine of the MRC variety.

That no one in the inter-war years could foresee quite what anaesthesia, or indeed medicine at large, would be like at the end of the century does not mean that human beings (or at least some of them) do not have the power to make, to some extent, their own destiny. That the anaesthetists of the inter-war years did manage to found an association that was singularly suited to later conditions was not a fluke. There were parties (factions even if we think of the MRC) within medicine at this time struggling to bring about a medical world based on the specialist, the laboratory, the professorial unit and the teaching hospital, none of which at this time had anywhere near the prominence and power it has today. There were those (perhaps a sizeable majority) within the early Association who were of this frame of mind. At the outset the number of members was limited to 150 and these were required to be practising at teaching hospitals. There was no provision for associate membership. General practitioners were excluded. In 1934, Ivan Magill proposed to inaugurate a diploma in anaesthetics. It was introduced in 1935 but not every Tom, Dick or Harry (or Mary) could attempt to gain one (the category 'Women' might have been a useful inclusion in the index). Candidates were required to have held resident appointments in recognised general hospitals for not less than 12 months, of which 6 months were to have been spent as resident anaesthetists. Candidates were also required to have given 1,000 anaesthetics. The diploma could also be granted without examination to anaesthetists in teaching hospitals who had been in the post for at least 10 years. This ruling had its embarrassing and now humorous consequences. Professor

Robert Macintosh did not qualify and so he sat the exam and, of course, passed it. The Association was fiercely opposed to the administration of general anaesthesia by persons who were not medically qualified, notably nurses.

The significance of all these points is that they show the Association to be a fiercely professional and specialist-minded institution at a time when most anaesthetists were not specialists and many were not medical professionals. In this sense of course it was not simply by mere good fortune that the Association was in an excellent position to negotiate when full time consulting positions appeared with National Health Service and later when university positions were increasingly created in teaching hospitals. The Association was, in fact, in line with the major powers in the medical profession and thus instrumental in bringing about the very world that, in some ways, it could not have precisely foreseen. Others were less instrumental and would have shaped the medical world differently (remember Lord Moran's crack to the effect that GPs were consultants who had fallen off the ladder).

A re-reading of this review makes it look like the Association was merely a self-serving interest group but that would be to miss the point. From the start the Association was at the forefront of trying to raise the standards of anaesthesia for everyone in Britain and from the start pretty well everyone in the Association agreed how this was to be done. It is hard to see in retrospect what other way was possible. But that would be to miss the point too. It is hard to see in retrospect because, to justify the best standards we have today, we appeal not to history but to the apparently immutable realms of science, the logic of specialisation, the necessity of teamwork etc. What a relative minority historically achieved is now seen to be right in other terms. This is why Featherstone's desire for a Craft or Guild gives pause for thought. How would those who wanted a Craft of Anaesthetists sought to have changed the shape of anaesthesia? There is plenty for everyone in this book and Tom Boulton is to be congratulated. This is both an excellent 'in-house' history and a valuable case study for the student of specialisation.

Professor Christopher Lawrence
Wellcome Institute for the History of Medicine

SHARED LAUREATE OF THE HISTORY OF ANAESTHESIA

The Wood Library-Museum of Anesthesiology announced in October that the Year 2000 Laureate of the History of Anaesthesia was to be shared by Dr Norman A Bergman and Dr Thomas B Boulton. Following this most signal honour for two members of our Society, it is with sadness we have to report that Dr Bergman has died shortly before the commencement of his Laureateship year. An obituary will appear in the next Volume of *Proceedings*.

AMB

Proceedings of the History of Anaesthesia Society

Index to Volumes 21 - 25

An index to volumes 1 - 20 appeared in Volume 20