

Some (mostly Scottish) local anaesthetic heroes

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ABSTRACT In 1884 a young Viennese doctor, Carl Koller, was the first to recognise the significance of the topical effects of the alkaloid cocaine and thus introduced drug-induced local anaesthesia to clinical practice. Most subsequent development took place in Europe and the United States, with British interest not becoming apparent for over twenty years. This is surprising because a number of doctors working in Scotland, or with Scottish connections, had made important contributions to the earlier evolution of local anaesthetic techniques. This paper reviews the relevant work of James Young Simpson, Alexander Wood, James Arnott, Benjamin Ward Richardson and Alexander Hughes Bennett and the role of John William Struthers in the later promotion of the techniques.

KEYWORDS James Young Simpson, Alexander Wood, James Arnott, Benjamin Ward Richardson, Alexander Hughes Bennett, John William Struthers

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INTRODUCTION

Before any form of anaesthesia could become a practical possibility several requirements had to be met: the concept of pain relief for surgery had to be developed, and a prepared mind had to identify an effective agent which could be administered from a suitable delivery system. The analgesic and soporific effects of ether and nitrous oxide were observed and reported long before 1844 when a Connecticut dentist, Horace Wells (1815–1848), was the first to employ the latter agent clinically. Wells's great insight was to realise that nitrous oxide inhalation would allow painless removal of the rotting stumps of his patients' teeth prior to the fitting of the effective dentures made possible by the new materials of the time. Unfortunately, his attempt to demonstrate the method publicly failed through a combination of his audience's scepticism and the lack of a suitable delivery system, the final component of the requirements for effective anaesthesia. Thus the credit for the 'discovery' of anaesthesia in 1846 usually goes to Wells's former partner, William Morton (1819–1868), who found an agent (diethyl ether) more suited to cruder administration systems, although the credit for the concept should go to Wells.

The same basic requirements for development applied to local anaesthesia, but a fascinating aspect is that both concept and administration system were conceived long before a suitable agent was identified. Decades were to elapse before a prepared mind recognised (like Wells) that the previously described effects of an available drug were the solution to a specific clinical problem. Many of the individuals involved in those

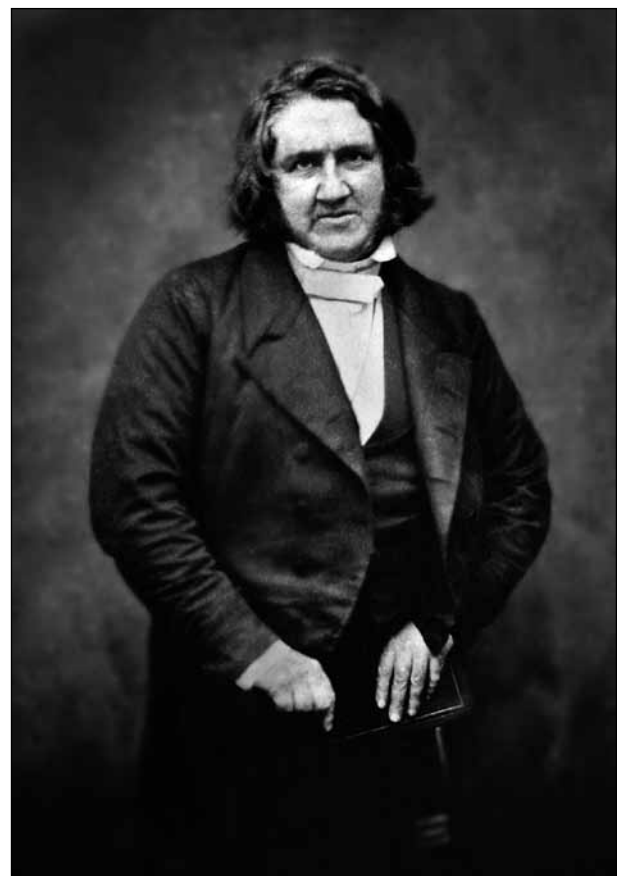


FIGURE 1 James Young Simpson (1811–1870). RCPE Collection.

earlier developments had a Scottish connection, and their contributions are reviewed here.

THE CONCEPT IS BORN

The term 'local anaesthesia' was first used in 1848, less than two years after the adoption of 'anaesthesia', to describe the effects of the inhalation of ether. James Young Simpson (Figure 1) published a paper in *The Lancet*¹ providing early insight into the potential benefit of producing local rather than general anaesthesia:

But if we could by any means induce a local anaesthesia without that temporary absence of consciousness which is found in the state of general anaesthesia, many would regard it as a still greater improvement in this branch of practice. If a man, for instance, could have his hand so obtunded that he could see and yet not feel the performance of amputation upon his own fingers, the practice of anaesthesia in surgery would, in all likelihood, advance and progress still more rapidly than ever it has done.'

Simpson also reviewed earlier attempts at producing 'peripheral insensibility', including nerve compression, and described his own unsuccessful experiments with the topical application of chloroform and other substances.

THE CONCEPT IS DEVELOPED AND AN ADMINISTRATION SYSTEM DEVISED

The concept of a peripheral approach to pain relief was developed further by one of Simpson's contemporaries in Edinburgh, the physician Alexander Wood (Figure 2), who was interested in improving the treatment of neuralgia. Others had tried applying morphine to the skin over the site of pain using a scarifying process similar to inoculation, but Wood reasoned that it might be more effective to inject the morphine close to the nerve supplying the painful area.² Both syringes and hollow needles had been developed by others, but Wood was the first to combine them for drug administration. He achieved some benefit, but through the systemic absorption of morphine, not from any local effect. However, in recognition of his work, Wood has been referred to, very appropriately, as the 'father-in-lore' of local anaesthesia. Wood and Simpson had much in common apart from their insights into local anaesthesia: they lived and worked in Edinburgh, each was subsequently President of the Royal College of Physicians of Edinburgh and they both lacked a drug which worked by the route of application they employed.

REFRIGERATION ANAESTHESIA DEVELOPED

Given his knowledge of the early, even antiquarian, literature, it is perhaps surprising that Simpson's paper on local anaesthesia made no mention of previous observations on the analgesic effects of cold. In the next edition of *The Lancet*, this omission was corrected in a

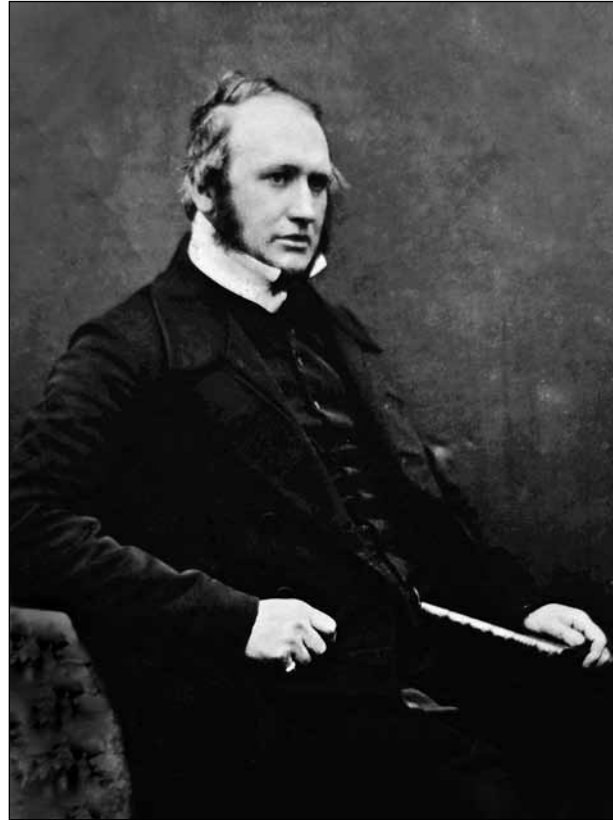


FIGURE 2 Alexander Wood (1817–1884). RCPE Collection.

letter from James Arnott, an Aberdeen-trained physician working in Brighton.³ Arnott was interested principally in the treatment of inflammation, but had noted that cooling had an analgesic action and suggested that it might be the local anaesthetic which Simpson sought. However there is no evidence of any response then or subsequently from Simpson, even though he continued to be interested in analgesia induced by topical application, studying the use of both chloroform and carbon dioxide for this purpose. A possible explanation for Simpson's lack of response might be that Arnott made some very critical comments regarding the risks of Simpson's beloved chloroform. A subsequent pamphlet cannot have helped endear Arnott or his method to the great man, being lengthily, but very critically titled:

Question considered – Is it justifiable to administer chloroform in surgical operations, after its having proved suddenly fatal in upwards of 50 cases when pain can be safely prevented, without loss of consciousness, by momentary benumbing cold?⁴

Arnott did not pursue the matter, becoming more interested in the therapeutic aspects of cooling and now being considered the pioneer of cryotherapy for cancer. However, others did undertake further study of the analgesic effects of cold, and Arnott's method (known as 'congelation' after he demonstrated it in Paris) was used

in both dental and general surgery.^{5,6} Unfortunately, the technique was cumbersome (involving the infusion of an ice/water/salt mixture through a thin-walled bladder placed on the operative site) and seems to have produced slow and inconsistent effects. Subsequently, the basic method attracted the attention of another early pioneer of anaesthesia, Dr (later Sir) Benjamin Ward Richardson (1828–1896), who worked in London after studying in Glasgow and qualifying from St Andrews. Richardson was a friend and colleague of the first specialist anaesthetist John Snow (1813–1858) and took an equally scientific approach to its development. Attracted to the concept of local anaesthesia by refrigeration, he sought a better method and eventually developed a spray utilising diethyl ether.⁷ Its rapid evaporation provided a more definitive and rapidly acting application of cold (ethyl chloride, being even more volatile, was substituted as the cooling agent after 1880).

COCAINE AND MISSED OPPORTUNITIES

When Simpson and Wood were developing their concepts, cocaine (the drug which would have worked for them) had not been isolated or named, although reports of the ‘exercise-sustaining’ effects of chewing the leaves of *Erythroxylon coca* had reached Europe from the time of the Spanish conquest of South America. However, little if any formal study had taken place because of the lack of both sufficient quantities of leaves and the chemical techniques that would allow isolation of the active principle. It was not until 1860 that Albert Niemann (1834–1861), working in Friedrich Wöhler’s (1800–1882) chemistry laboratory in Göttingen, was the first to isolate pure white crystals (which he named cocaine) from coca leaves; he was also the first to note that they had a numbing effect on the tongue.⁸

Limited availability of the raw material may have continued to restrict study, but several people made observations which, in retrospect, are notable. One of these individuals was a young Edinburgh graduate, Alexander Hughes Bennett (Figure 3), son of the Professor of Physiology at Edinburgh University. In 1871, Bennett studied a range of plant alkaloids while working for his MD thesis in his father’s laboratory. He observed the effects of injecting cocaine in a range of animals and was almost certainly the first person to record that large doses produced convulsions and respiratory arrest.⁹ In addition, almost hidden away in the list of his experiments with cocaine is the following report:

Right calf of leg injected. After no movement on irritation, on pinching left calf movements of entire body, including right leg.⁹

The significance of this clear demonstration of sensory block was missed, although other workers also failed to

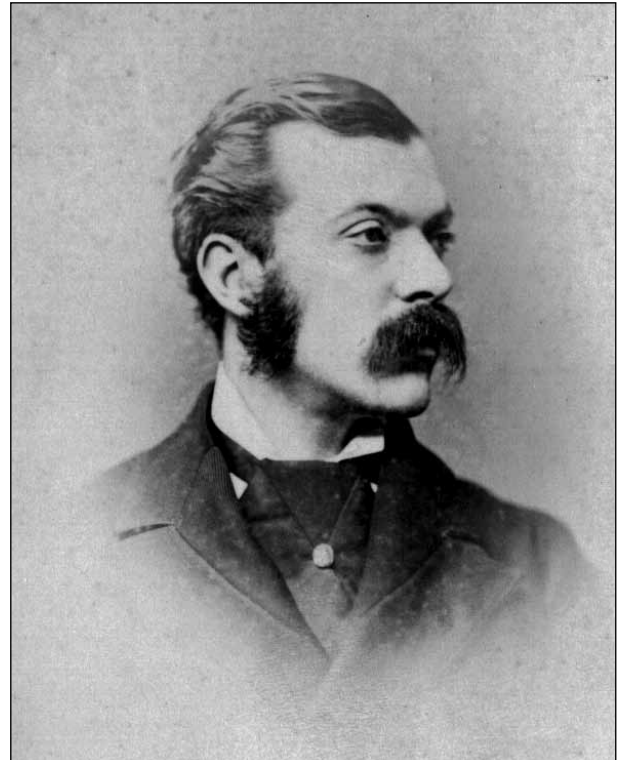


FIGURE 3 Alexander Hughes Bennett (1848–1901). Image courtesy of the Royal Medical Society.

recognise the implications of their own observations of cocaine’s local effects. The failure to translate these effects into clinical practice is perhaps even more of a mystery than the failure to utilise the effects of nitrous oxide and ether prior to the 1840s. The introduction of general anaesthesia did at least require acceptance of an entirely new concept, but the term ‘local anaesthesia’ had, as noted above, been coined very soon after, and methods for its production had been sought. The significance of Bennett’s observation might have been better appreciated, although his evidence that cocaine is a highly toxic substance may have contributed to his failure to do this himself.

THE PREPARED MIND

In most aspects of nineteenth century surgery, the availability of general anaesthesia was a source of comfort to both patient and surgeon, but this was not the case in ophthalmology. Vomiting during recovery from general anaesthesia with ether or chloroform could be severe enough to rupture the surgical suture line and cause extrusion of the contents of the globe. Thus the consequences of operating could be worse than doing nothing, so some surgeons had returned to operating on the conscious patient in order to avoid the problem. The need for an alternative to ether and chloroform was recognised by Ferdinand Arlt (1812–1887), Professor of Ophthalmology in Vienna, who

believed that a local anaesthetic suitable for ophthalmic work would be of great benefit. This led Carl Koller (1857–1944), then a young Viennese doctor with aspirations of becoming an ophthalmologist, to test the conjunctival application of a number of substances, but they were all ineffective.¹⁰

In 1884 Koller's close friend, Sigmund Freud, became interested in cocaine, hoping that it might have therapeutic applications. Freud reviewed the literature, planned a series of studies of systemic effects and asked Koller to help. It was while demonstrating (to a third party) the tongue numbing effect of 'tasting' cocaine that Koller realised that it might be the local anaesthetic which he had sought earlier. Conjunctival instillation in animals led quickly to personal experimentation and on to successful use in operative surgery before the discovery was announced at an Ophthalmological Conference in Heidelberg.¹¹ Almost forty years earlier the news of general anaesthesia had taken six weeks just to cross the Atlantic, but the news of local anaesthesia was around the world in a few days courtesy of the electric telegraph. It was a landmark event, prompting the comment:¹²

The loneliest doctor in the world is the ophthalmologist who hasn't written an article on cocaine.

SUBSEQUENT DEVELOPMENT

The new discovery was met with great enthusiasm in both Europe and the United States, with most of the nerve block techniques we know today being developed on one or other continent within a couple of years of Koller's discovery. However, cocaine is a poor local anaesthetic for anything but topical application in relatively small doses, and wider use was limited by its toxicity, its addictive nature and the difficulty of sterilising solutions. It was only when new local anaesthetic drugs were synthesised, particularly procaine (in 1904), that the more major nerve blocking techniques could be used in relatively safety. None of this development took place in Britain where local methods do not seem to have been used much until well into the first decade of the twentieth century. In Dundee Royal Infirmary, for example, there is no record of spinal anaesthesia being used until it is mentioned in the Annual Report for 1908–9.¹³

This was shortly after publication of a slim volume entitled *Local anaesthesia in general surgery*, written by John William Struthers (Figure 4).¹⁴ Struthers was then a Clinical Tutor in The Royal Infirmary of Edinburgh; later he was a Consultant Surgeon there and President of the Royal College of Surgeons of Edinburgh. The contemporary importance of his book in promoting the use of local anaesthesia in Britain is evident from Struthers's obituary in *The Lancet*:¹⁵

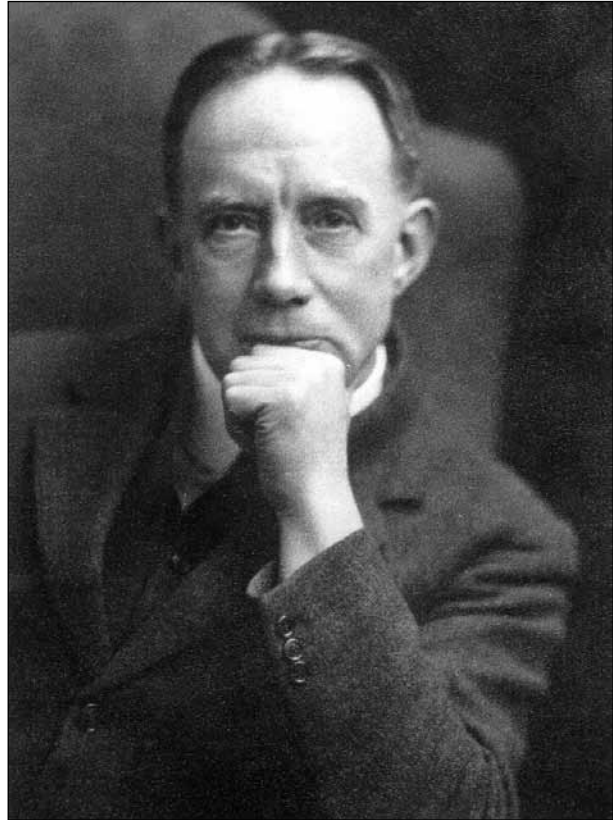


FIGURE 4 John William Struthers (1873–1953). Image courtesy of the Royal College of Surgeons of Edinburgh.

His monograph (1906)... was for long the best source of information on the subject in English.

Struthers's book notes that most of the development of local anaesthesia had been in France, Germany and the United States, but there is (unfortunately) no indication of how he became interested in this aspect of anaesthesia. Because of World War II Struthers worked long after the normal retirement age so he may have had some influence on HWC Griffiths and John Gillies in their choice of spinal anaesthesia (one of the techniques described in Struthers's book) for their seminal study on induced hypotension published in 1948.¹⁶ From this work the Department of Anaesthesia in the Royal Infirmary of Edinburgh developed a major interest in local anaesthetic techniques during the second half of the century.

CONCLUSION

A number of doctors with significant Scottish connections played notable roles in the early history of local anaesthesia. In Edinburgh, James Young Simpson coined the term and tried to produce it by topical application, Alexander Wood tried to achieve analgesia by perineural morphine injection, and over a decade later, in 1871, Alexander Hughes Bennett produced, but did not

recognise, local anaesthesia by cocaine injection. Simpson and Wood might have seen the importance of Bennett's experiment, but by 1871 Simpson was dead and Wood had given up medicine to work for Edinburgh's first tramway company.¹⁷ It was not until 1884 in Vienna that Carl Koller made the key connection between observed effect and clinical application. Otherwise, all the early heroes of local anaesthesia might have had Scottish connections.

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