Experiments in pneumatic chemistry paved the way for medical innovation in the last quarter of the eighteenth century. Thomas Beddoes and James Watt were instrumental in the spread of the use of new gas chemistry in pneumatic therapy, but they were far from alone. There was no shortage of experimental subjects, as the practice was quickly taken up by medics throughout Britain.

**Keywords:** chemistry; experiment; medicine; Watt; Beddoes; Thornton

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**Sites and Subjects**

In the late autumn of 1787, HMS *Vestal*, under the command of Sir Richard Strahan, lay waiting in the English Channel for fair winds. Her mission was to convey the embassy of Sir Charles Cathcart to China. Cathcart’s brief was to open British communication with the Emperor and to establish a depot on the coast of China. However, the winds remained against them until 21 December, when they managed to set sail for the Madeiras. Passing through violent weather, the warmth of the Madeiras was welcome against the winter cold. Yet the voyage southward was plagued with problems: a ship that ran deep, washed by heavy seas and then becalmed for two weeks ‘under the line’, and beset by a contagious dysentery among its crew before reaching Cape Town in March 1788.\(^1\) It was an unpromising beginning.

Cathcart also carried a cargo that he could not shake. Cathcart was consumptive—and the Admiralty knew it. In November 1787, in supplementary instructions, Captain Strahan was ordered that if Cathcart’s indisposition became critical before arrival in China, Strahan was to return immediately to an English port.\(^2\) Phthisis, which Cathcart believed had inflicted him from infancy, became ever more violent on the voyage, the cough and purulence, chest pains and hectic fever made worse by intense cold and endless damp.

Cathcart was not without assistance. On board was his personal physician, John Ewart, part of the Scottish diaspora throughout the Empire. From the shipbuilding town of Dumfries, Ewart found himself Cathcart’s last hope. Ewart was well acquainted with...
pneumatic chemistry, notably the suggestion by Joseph Priestley that inspiration of mephitic air had reported some success in pulmonary illness. Crossing the Indian Ocean, Ewart ultimately felt ‘justified in having recourse to any means . . . that offered a possible chance of relief in a case so desperate.’ He had with him a Nooth’s apparatus, used for impregnating water, which he subsequently adapted with a tube to be used by Cathcart in the inhalation of mephitic air, produced on board from marble and vitriolic acid. The procedure was ‘renewed three, four, and sometimes five times a-day: and no inconvenience or uneasy feeling was occasioned by it to the patient. On the contrary, [Cathcart] expressed himself somewhat relieved after it, and wished to repeat it oftener than I chose to venture.’ As it turned out, ‘none of the symptoms were ever entirely suspended.’ By May, Cathcart’s condition so declined that Ewart recommended a change of course to Macao to try to effect a recovery. Despite pneumatic trials of six or seven weeks Cathcart survived no further than Java, and before mid June the expedition turned for England.3 Not atypically, Cathcart had remained ‘satisfied to the last that it contributed to a considerable degree to alleviate his sufferings.’4 His disease proved so far advanced that, Ewart thought, little could have been done even with the best promises of pneumatic chemistry.

This incident was hardly exceptional, either in result or misplaced hope. The failure of Cathcart’s embassy was a minor intersection of a far too common desperation with the promises of pneumatic chemistry. Of course, Priestley was far from being the only influence.5 If trials could take place on a long voyage to China, it was not surprising that throughout the 1780s there was also a widespread interest in what pneumatic chemistry might effect. In the Memoirs of the Royal Society of Medicine in 1785, Antoine Lavoisier assayed the effects of airs on the transmission of disease. He tested the airs of the General Hospital in Paris and the chemical differences between the air in the box at the top of the theatre of the Tuileries and that sunk into the pit. He drew attention to the need to design buildings so as to renew airs, or otherwise ‘spectators would be exposed to the most fatal accidents before the conclusion of the performance.’ This might explain why audiences in closed spaces cannot stay awake ‘above two or three hours.’ This may give pause, but it got worse. Atmospheric air was a ‘chemical agent capable of taking up, in the way of solution, miasmata of various kinds’—thus, alarm might arise on considering how often in a large assembly, the air which each individual breathes, has passed either wholly or partly through the lungs of all those who are present. It must take up in each case exhalations more or less putrid. But of what nature these exhalations are: to what degree they vary in different subjects: in age or youth: in health or sickness: what diseases are we capable of receiving by this mode of communication: . . . there are none of these subjects which may not afford ground of inquiry . . . .6

THE AIRS OF HOPE

Just as Cathcart’s embassy had been fitting out, Thomas Beddoes was contemplating a shorter, warmer, journey across water, this time to France and to Dijon, where he would encounter a world of promise. In the summer of 1787, shortly after he returned from Joseph Black’s lectures in Edinburgh, Beddoes left Oxford to pay a visit to Guyton de Morveau in Dijon. This would magnify what Beddoes came to perceive as the vast hope lurking in the new gas chemistry. Pneumatic promise became a widespread passion.
In 1786, James Watt in Birmingham was writing to Black about chemical communications received from Guyton and Priestley. Even so, Watt then claimed to have given up on philosophical and chemical subjects, and resolved to ‘try no experiments of any kind myself, now.’ As we shall see, this was more than slightly disingenuous. And by the end of 1786, Beddoes had taken his MD at Oxford. During the next summer Beddoes spent time in Dijon with Guyton de Morveau at his ‘ingenious’ laboratory. It was there, by coincidence, that Beddoes met the travelling party of Antoine Fourcroy, Claude Louis Berthollet and Antoine Lavoisier.

By the 1780s a rising interest resided in the physiological effect of new airs. Yet, what certainty lay in airs few then knew. Many trials would be necessary. No wonder the desperate on board ship to China would link hope to a wisp of air. Several years earlier, Priestley had enlisted Matthew Boulton in obtaining samples from Birmingham, in glass phials, from ‘those places where you expect the air to be the worst, on account of bad fumes or a number of people working together, and not at your place in the country, but in the middle of town of some of your closest streets’. Airs thus afforded opportunity for experiment, and implied remedy as well. In 1786, the Manchester physician Thomas Percival, after a conversation with Priestley, took up pneumatic chemistry as essential to public health. Writing to James Watt, Percival made a particular point of the affliction of the residents of Manchester with pulmonary disease. He believed that this followed from the spread of industrial ‘fire engines, furnaces, & other work’. Amid satanic mills, Percival demanded that local magistrates adopt

some measures for the purification of the air of Manchester. For they are guardians of the health, as well as the morals of their fellow citizens. And though works which are necessary for the prosecution of trade, ought not to be deemed nuisances, the persons who are engaged in them, should be induced, or enjoined, to conduct them in a manner as little injurious as possible to the public.

The physician-botanist William Withering of Birmingham wrote to Beddoes remarking on the apparent convergence of occupations and consumption. He pointed out that those working in fine brass castings ‘very often die consumptive, much more so than any other set of artists in Birmingham’, possibly from the powdered rosin that rose from molten metals in the moulds. Withering supposed that consumption was ‘caused by the mechanical action of powdery matters’ in the casting shops. He further pointed to the breathing of flints pounded in mortars in the potteries or to the circumstances of the grinders of needles so that those ‘so employed universally died consumptive’. The freshening air of a sea voyage or of a warmer climate was unavailable to them. Their survival depended on experiment.

The passion for pneumatic medicine

While the doctors muddled through, chemists proposed a new alchemy of airs. Fourcroy, reading the public press, noticed that the English had described the cure of cancers by the application of carbonic acid air. Fourcroy’s own subsequent trials had failed, yet Ewart later reported that the method of application was as critical as chemical properties. It was thought that carbonic acid air had the effect of diminishing the presence of the inflammatory and irritating oxygen and, properly applied, might induce an antiseptic benefit. Moreover, to establish such properties with accuracy ‘would require experiments
which have not yet been made, instead of an imaginary theory, with which medical ethiology has been burthened.’ Similarly, in 1786, Caleb Parry, physician at Bath, had also concluded from Priestley’s work that the chemistry of respiration urgently needed much more exploration. The essential question was how laboratory chemistry could be advanced by experimental subjects or employing desperate patients.

Whether amid the ‘wave-hits’ on rough seas to China or among coughs in a Manchester infirmary, the contemplations were the same: what chemical armoury could be enlisted in the conquest of disease? In the laboratories and workshops of Birmingham and of Stoke-on-Trent, by what means might airs give up their secrets? By what devices? The doctor’s surgery and the experimental laboratory or workshop thus had overlapping boundaries, the lines of action between trial and therapy blurred, space and practice merged. On his return to England, John Ewart had settled as physician to the Bath City Infirmary and Dispensary. There he applied the new chemistry in treatment of tumours while claiming that ‘no preconceived theory has had any share in biassing my judgement of the practice which I have related.’ The basis of his approach, even as physician, was not solely to ameliorate the symptoms of the sick: it was also to ‘obtain knowledge of more facts by experiment’, especially with the ‘different factitious airs’.

This empiricism evaded the broader speculations of theory and classification. It spoke directly to assertions of practical consequence and experimental histories appealing to both chemists and physicians alike. Hence, instrumental innovation was immensely seductive. Instruments could find common roles across many sites of investigation. In chemistry, Nooth’s apparatus, designed by a surgeon at Bath, was not only used in the infusion of water by fixed air, and later improved by the instrument maker Jean-Hyacinthe de Magellan and the surgeon-apothecary William White, it was deployed at Bath and London in the treatment of tumours. There were many such examples, the most common early attempt being the inhaler designed by John Mudge of Plymouth, essentially identical with that promoted by White at Bath and redesigned by Withering in Birmingham. In this respect the evolving apparatus reflected precisely the chemists’ experience of the rapidly expanding instrument trade. Makers in London, such as the Portuguese Magellan and the Neapolitan Tiberius Cavallo, were concerned to ensure that cost and complexity did not obstruct chemistry. Like Mudge’s tankard, Priestley had adapted as much simple kitchen apparatus as he could. Cavallo likewise asserted that with eudiometers and thermometers, as with the market in barometers, ‘after various complicated constructions, the simplest of them has been found to answer the best’. Instrumental simplicity served ample polemical purposes and eased the aerial investigations that would seduce both Beddoes and Watt.

JAMES WATT’S AIRS

Well before Beddoes became entangled in pneumatic remedies, James Watt was busy with chemistry in his garret workshop. Although Watt’s chemical interests have, until recently, attracted little attention, they seem to have been familiar among his contemporaries. John Ewart thought of him as ‘one of the most accurate experimentalists of the age’. Watt’s engineering reputation has eclipsed his broader pneumatic interests, although the very issues of the expansion of steam or the decomposition of water were hardly very far afield. Yet, in the middle of the 1780s, when pneumatic chemistry was the rage among
philosophers, Watt complained that ‘The ardor of youth, and the pleasure of experimenting
have been obliged to give way to the necessity of attending to business’. This was chronic
among Watt’s lamentations. But Ewart, at Bath, later told Watt that as a physician he had
gained much from ‘the attention of your accurate & inventive mind to the application of
airs in diseases’. The reason for this, Ewart argued, was that ‘You engage in the subject
with fewer prejudices, and are therefore likely to see more clearly & to report more
faithfully the result of your experiments, than most physicians are.’ Experiment was as
important to physicians as to chemical philosophers.

James Watt’s tragic experience of consumption, within his own household and family,
reinforced the compelling promise of new airs. Watt’s loss, in 1794, of his only daughter,
Jessy, to consumption took him through grief to pneumatic medicine. He soon provided
Beddoes with an extensive list of the substances that might be employed and, most
critically, the manner in which to do so. Watt recommended, besides oxygen, the calx of
zinc, inflammable air, fixed air, azotic air, and nitre. He argued, ‘It would be desirable
that a list were made out of all substances, which are known to be soluble in air of any
kind, or are of themselves reducible to vapour or steam, that experiments may be made
upon their sanative effects in cases of diseased lungs. The list will prove more numerous
than may appear at first glance.’ The idea, in part, was to overcome diseases exhibited
with the ‘super-oxygenation’ of the blood.

There were manifold ways to encourage tests on the salubrity of airs. Besides the adoption
of new instruments, the best way forward was the dissemination of information and the
encouragement of chemists and medics to report their experiences, whether in the
laboratory, the infirmary or the hospital. It was Beddoes’s aim to attract as many
independent reports as possible. In this he was singularly successful. He held that ‘The
more widely any species of knowledge is disseminated, the more rapidly may we expect
that it will make advances.’ He thus echoed Priestley’s earlier proto-democratic manifesto
that ‘progress might be quickened, if studious and modest persons, instead of confining
themselves to the discoveries of others, could be brought to entertain the idea, that it was
possible to make discoveries themselves.’ Beddoes later argued that ‘by multiplying the
number of minds in activity, we multiply the chances of fortunate combinations.’ But it
was critical that a credible, deliberate, method of experimentation be achieved. This was
the proposal put by James Watt.

The furnaces and vials of the laboratory manufactured risk. The effects of airs proved a
great deal more dangerous than Watt might have expected. In his own laboratory he tried, as
a curative, the production of what he described as a ‘heavy inflammable air, or carbonated
hydrogene, being principally a solution of charcoal in inflammable air.’ Watt went first,
breathing through a tube until it made him giddy and unable to stand, finally followed by
nausea. He told Beddoes that

Another young person, merely from smelling... it as it issued from the bellows, fell upon
the floor insensible, and wondered where he was when he awaked. None of us experienced
any disagreeable effects in consequence of the vertigo, &c. only in going to bed six hours
afterwards, I felt some small remains of the vertigo. Several other persons have inhaled it
since; and all were affected in the same manner. I have no doubt, from what I have
observed, that if inhaled in a pure state, this air would speedily bring on fainting and
death; when given as a medicine, it ought therefore to be much diluted with common
air, I should think with 12 times its bulk. Its effects upon diseased lungs you are better
qualified to speak to, and I trust you will give the necessary cautions for the use of so active a medicine, in a more distinct manner than I am qualified to do.²⁸

Life in the laboratory might prove as hazardous as in mills or mines. Watt certainly felt that gases sometimes dramatically affected him. He tried dephlogisticated airs, variously prepared, nitrous airs, and ventured a mixture of azotic and fixed air. His assistants breathed the concoction without any ill effects, although Watt found no difference from breathing fixed air. Self-experiment was part of the general procedure of the chemist.²⁹

Watt’s accounts revealed the risks of unknown airs, some experiments giving off foetid odours that proved highly debilitating. Even when attempting to avoid these undetermined gases, some were so pervasive that the slightest breath plundered his senses. In one incident described to Beddoes:

Though none of either of the airs was inspired, that could be avoided, I had a slight, though uncommon, nausea, attended with some elevation of spirits, all that evening, but no heat or thirst. In short, it was very like the effect of the fumes of tobacco on an unexperienced person: In bed I was restless, though not without pain or particular uneasiness, I could not sleep. Next day the nausea, and some giddiness, continued, or rather increased, and a head-ache come on.—The uses of this air, if it has any, I leave you to find out. I think I shall have no more to do with it, or with animal substances: One may discover, by accident, the air which causes typhus, or some worse disorder, and suffer for it.³⁰

**AIRS AMID THE INFIRMARIES**

Dread and helplessness commanded desperate remedies. Even so, the subjects of both pneumatic trial and therapy proved the certain fatality of most pulmonary diseases. Within a few years of the unfortunate Cathcart, Beddoes collected reports from physicians who had ‘seen ten [thousand] or, perhaps, twenty thousand patients’ with consumption, of which 99 per cent had resisted any intervention. To have gathered these histories was sufficiently onerous, but to compare the reliability of testimony from the few who survived was a monumental problem. Only where we find traces of the subjects, of experiment or of urgent remedy can we now appreciate the urgency of the many trials.³¹

Consequently, in the late eighteenth century there was often little difference between the laboratory experiment and medical relief. Airs including oxygen, nitrous oxide, fixed air or carbonic acid air were tried in specific human complaints. Beddoes pointed not only to William Withering’s adoption of carbonic acid air in ill-defined wasting diseases in Birmingham but also to Thomas Percival’s use, in Manchester, of fixed air in ubiquitous lung disorders.³² Indeed, Withering himself commented on Percival’s experience with a carbonic acid air. Beddoes reported to his friends that there was ‘the best reason to hope that Cancer, the most dreadful of human maladies may by some of these substances be disarmed of its terror & danger too.’³³

Although Beddoes was an exceptional projector of aeriform fluids, he was far from alone. However, there were as many obstacles as there was enthusiasm. Even where apparatus for the preparation of airs was available, as in the Manchester Infirmary, their apothecary came close to an explosion while obtaining hydrogen. Moreover, the medical men of Manchester often proposed that trials could be answered by their own apparatus although, according to the chemist Thomas Henry, the proliferation of designs produced little success.³⁴ This could
not be surprising. Even being ‘present at many hundreds of experiment’ provided little confidence in the results. This was especially problematic when a human subject was involved.\textsuperscript{35} And the reliability of testimony was always an issue, and became even more so when the physician made himself the experimental subject. This was true, for example, of the remarkable Dr James Currie of Liverpool, like Ewart formerly of Dumfries. In 1784, among his many trials and misadventures, Currie lost three of his sisters to consumption and apparently remained consumptive much of his life. All that could be achieved in his own case was self-therapy in a change of place from the sea shore to inland or to mountains.\textsuperscript{36}

Watt’s household was a pulmonary laboratory. His trials allow us to retrieve from obscurity some of the many subjects who became part of a grand experimental exercise, to test the new airs and, if lucky, to escape the tide of pulmonary afflictions. One afflicted was Rebecca Stanley, a 35-year-old servant to Watt, who was attended by the Birmingham surgeon John Barr. According to Barr, she remained in extreme difficulty even after Watt attempted to assist her breathing by a variety of treatments, including the ubiquitous laudanum, and significant inspirations of hydrocarbonate.\textsuperscript{37} A year later, Barr was engaged in another Watt case. This involved Richard Newbury, 46 years of age, a labourer employed by Watt. Newbury was repeatedly intoxicated and suffered from haemoptysis, characterized by expectoration of the blood, possibly of tubercular origin. Watt had prepared and prescribed inhalations of hydrocarbonate but called in Barr and the Birmingham physician John Carmichael. According to Carmichael, ‘Newberry himself uniformly expressed much thankfulness for the benefit he invariably received from breathing hydro-carbonate. Had the inhalation of the modified air been repeated more frequently, [he speculated] would it not alone have been adequate to the complete removal of the pain of his side, and consequent cure?’\textsuperscript{38} Watt apparently had few qualms in advancing factitious airs in cases of his own servants. He was nevertheless very cautious as to their chemical preparation and in their concentrations, specifically in prescribing the inhalation of oxygen and hydrocarbonate, in what he clearly accepted as an experimental process.\textsuperscript{39}

There was much difficulty in procuring the airs and the ability to draw on them once secured; hence, the production of a portable device by Watt was critical to the enterprise. Beddoes revealed:

\begin{quote}
In several instances under my eye, a servant of plain understanding has managed the apparatus perfectly: in one a maid servant has proved quite equal to the task. When inexperienced operators have failed, it has been from setting the water to drop before the charge in the furnace was red-hot, or letting it drop too fast afterwards. Hence they get steam instead of air. When the joints are made tight, and the heat is proper, and the water does not drop too fast, the operation proceeds perfectly.\textsuperscript{40}
\end{quote}

Beddoes was buoyed by requests from physicians for apparatus. The demand was so great that, as in Watt’s engine-building business, they searched for an assistant who might undertake setting up the devices.\textsuperscript{41} Watt was so inundated with requests for his design of furnace and breathing apparatus, he arranged that they could be had by private practitioners through, of all places, Chippendale’s in Fleet Street, London.\textsuperscript{42} Chemical apparatus, like the increasingly popular electrical machines, had evolved into medical therapy.
Pneumatic medicine spread rapidly beyond the industrial Midlands. And far from Beddoes’s promotions in Bristol, increasingly, urban air compounded illness. Amid London’s polluting smoke the physician Robert Thornton, seeing endless cases of pulmonary disease, took up the cause. After consulting with the chemist Adair Crawford at Woolwich, Thornton treated Frederick, Duke of York, with oxygenation and was called to Southampton to deal with a disorder of the optician George Adams Jr. Thornton claimed to have endured phthisis himself. Crawford attacked his own consumption with hydrocarbonate, declaring ‘that it transfused over his body at the time of soothing tranquillity, such as opium is known to produce, but with slight vertigo.’ Crawford gained some relief but survived no more than three months after this experiment in 1795.

In his treatments, Thornton was aware of the cautions of Barr and Carmichael in the administration of airs. Regarding the effects, there was then no method apart from trying the new airs on the willing. Thus, in a case of oedemas, Thornton opted for a cautious trial of hydrogen. Similarly, hyperoxygenation might affect restoration of colour, according to some testimonies, but it was difficult to tell whether only the symptoms were altered. Thornton even speculated that as ‘With electricity I make no doubt it will be found the most effectual cure for chlorosis’ (green sickness).

Thornton encouraged Watt in the manufacture of the apparatus. Watt was thus, according to Thornton, ‘a gentleman who has so much improved the Science of Medicine’. Thornton had his own breathing device, ‘constructed a long time back’, that had a weight balanced to move along a scale to show the ‘exact quantity of air consumed’. This Watt may have seen in London. By the summer of 1795, Thornton told Watt he was ‘anxious now to multiply practitioners’. The essential obstacle, as in so much of experimental practice, was the availability of reliable devices. Thornton’s solution was clear. It was critical that Watt turn his mind ‘towards the contrivance of a graduated glass apparatus, & tin japanned reservoir, & having these in abundance, & at a moderate price, neat, simple, & elegant, they could encrease the role of pneumatic apparatus, & extend the benefit of your discoveries as well as those of Dr. Beddoes’.

Despite all the difficulties, there was a continuous seduction of patients and practitioners by new airs. By the summer of 1795, Thornton claimed that no one besides himself had a pneumatic practice in London. True or not, much can now be learned from Thornton’s trials. He certainly seems to have had sufficient opportunities, perhaps 15–20 patients a day. Thornton claimed he could show Beddoes 15 or 16 cases then ‘deemed incurable, where air slightly aided by oxygene produced considerable alteration’. But many problems arose in the application, especially in rooms filled with ‘a prepared atmosphere. There it must necessarily be very much diluted, & a great doubt was would such a dilution have any effect, and if the dilution was little could the patient bear long to breath it.’ Direct inhalations were the immediate answer. Therapeutic innovation enlisted subjects in both chemical and physiological trials. Beddoes, however, was alarmed at Thornton’s ‘wish to monopolize the pneumatic practice’ in London. He need hardly have worried. There were reports from Manchester of the success in the pneumatic treatment of cancers and ulcers, and from Ewart in Bath on the use of carbonic acid air in breast cancers. Moreover, Thornton reported on the equally astonishing use of oxygen in cases of gutta serena, or a generalized loss of sight. One lady claimed her sight miraculously restored (enabling reading the small print of the prayer-book); another, the sister of Lord
Walpole, was treated in London by the surgeon Daniel Hill. Here ‘Electy. was conjoined with the vital air. She cd. not discern, as she told Mr Wathen [the physician at St Thomas’ Hospital], the dial-plate belonging to the Horse Guards clock, but before she left him she cd. readily perceive both the hour & minute hands.’ Wathen encountered a case of gutta serena in a boy, deemed incurable, after seven weeks in St Thomas’. Wathen ‘sent him to inhale the vital air. In 4 days he [reported he] had a glimmering of sight & in 15 discerned objects.’ With reports like these, the rage to try the airs could hardly subside.

CAUTIONS

The seductions of experiment remained compelling. But there were many difficulties in determining the qualities of airs. Assuming a common and reliable method of production, the means of application was as uncertain as the reliability of reactions. Patients reacted variously even when the physician took precautions. Thornton reported that ‘One Quart of Hydrocarbonate to 100 pints of Atmospheric produced Giddiness in Dr. Crawford, & he could not inhale the whole.’ As we know, Adair Crawford did not long survive the trial. The chemist or physician was often faced with many a subject who was too far gone to judge what benefit pneumatic chemistry might possibly effect. Take, for example, the Glasgow physician Robert Gleghorn, who recalled his own trials on four patients, all of whom died: ‘Two of them were hopeless before the air was tried, but none of my patients experienced any kinds of the sensations said to happen so uniformly with you. The heat-pain-oppression &c. all continued totally unaltered.’ Similarly, ‘the application of carbonick acid air relieved one case of Cancer very remarkably, but failed in all the rest.’ Even so, Gleghorn, echoing Ewart and Beddoes, told Watt that

Those who oppose these trials, & still more those who ridicule them, deserve the reprobation of every lover of mankind—but it was always so & always will be while the profession of physick is follow’d as a Craft. Improvements must come from such men as yourself, or some of your Coadjutors whose circumstances are somewhat different from those of our profession in general.

In the eyes of medical reformers, nothing should be permitted to inhibit pneumatic trials. This frequently meant self-experimentation. Thus, John Seward of the Worcester Infirmary wrote to Watt asking for apparatus for the preparation of oxygen and hydrocarbonate as ‘I at present think of trying again the effects of hydrocarbonate on myself.’ Throughout the next month Seward was breathing assorted airs and dealing, not too surprisingly, with a persistent cough. His symptoms were meticulously recorded after ingesting hydrocarbonate diluted with common air:

It affected my head very much that is I felt a remarkable tinnitus aurium & pain in the forehead, wch was greatly increased by stooping or using any exertions. My heart also I could perceive by my hand as I breathed beat more feebly. ...I am now breathing diluted oxygen from which I feel no sensible effect whatever. I shall try afterwards a union of the two.

Not to be outdone, Beddoes and Watt discussed their own self-experiments, although the details here are surprisingly scant. However, there was much mention of trials on the afflicted. Pneumatic experiments turned chemists into medics.
The vast number of reports of pneumatic trials were as compelling as they were extensive. We obviously know nothing of the reactions of many subjects. However, in some circumstances at least, those who tried the airs already had an interest in chemical matters or were brought to physicians as likely candidates for the new aerial therapies. The range of subjects, experimental and medical, was substantial, from small children to physicians, to Members of Parliament and even to the Royal Court. There were, at one extreme, Watt’s household servants. But there were also medics such as William Cochrane, an apothecary in London, who was himself under Thornton’s care for a haemoptoe (a bloody discharge from the lungs); others were James Gray, the editor of the Whig paper the *Morning Chronicle* who died of consumption, and of course the young radical Lord Daer, a member of the Chapter Coffee House Society whom Beddoes tried unsuccessfully to treat for consumption. It would be very surprising if, among the thousands of cases whose symptoms and names Beddoes had recorded (he claimed some 3000 alone in 1803) there would not have been some of prominent social standing. Prominence, of course, could provide a singular credibility to a new therapy. And if this number is accurate, it obviously included the reports of the likes of Robert Thornton and many others farther afield. By the end of the century, pneumatic practices were substantial. In Beddoes’s own lists were Mr Tobin (probably the radical James Webb Tobin) and one of the sisters of Horace Walpole. It is likely that Mrs Keir, the wife of the chemist James Keir, might have been one of those whom Beddoes treated for fever. He also tried azote, later prepared by Humphry Davy, on Mr Green, the MP, for some obscure pulmonary difficulty.

Significantly, not all subjects were ill. Beddoes was fascinated by the experimental attempts at breathing pure hydrogen. Moreover, everything seemed to depend on the reactions reported by the subjects, ill or not:

> I have remarked them in a number of healthy persons who were curious to try how long they could breathe this air. The frequency and debility of pulse, blueness of the lips and coloured parts of the skin, were always observable in a minute, or a minute and an half. Besides, dizziness was felt, and the eyes have grown dim; in animals, the transparent cornea has appeared sunk and shrivelled. Several individuals agree in describing the incipient insensibility as highly agreeable. One consumptive person loved to indulge in it; for this purpose, contrary to my judgment, he used to inspire a cubic foot of hydrogene at a time. This quantity most commonly produced little change in his feelings. Sometimes it brought on almost complete asphyxia. During this process, I have felt the pulse nearly obliterated. Afterwards, as he recovered, it was sensibly fuller, and stronger than before the inspiration.

Typical of the experimental adventurers in the last decades of the century was Miles Partington, the apothecary and electrotherapist. Partington told James Watt that he had not at first been convinced of the efficacy of pneumatic chemistry. However, he obtained a portable apparatus from Chippendale’s and ‘received the most pleasing & satisfactory conviction of the power of oxygen in restoring the loss of voice, in my wife of three years standing.’ She had suffered greatly from difficulties of breathing and ‘spasmodic affections’. To give her some relief, presumably where electricity had failed, Partington entered into a course of oxygen at his own house that ‘succeeded in the most ample manner’. This induced him to ‘pursue the Experiments more fervently & with the
encouragement of my Medical Friends, to enter more at large into the Practice.’

Even among electrical practitioners, new airs held out hope.

LAST GASPS

The circle of experimental subjects was clearly vastly wider than the dens of Birmingham or of Bristol Hot Wells. Practitioners such as Beddoes, and experimenters such as Watt, had to admit that no one could yet be certain of the consequence of inhalations of ‘unrespirable airs’ beyond a marginal or momentary effect—even when reports were entirely enthusiastic. However, on these trials there inevitably lay a political tension. In disease, especially in one as ubiquitous as consumption, no prophylactic preserved masters more than servants, or factory proprietors more than mechanics. In disease, Beddoes argued, Edmund Burke had no sound reason to imagine the ‘numerous gangs of our manufactures’ might envy their social betters. While looking at Revolution, Burke would construe a mob breathing intoxicating remedies when ‘The wild gas, the fixed air, is plainly broke loose.’ But, for Beddoes as for Priestley, no social distinctions could be promoted in a democratic experimental practice. Medical remedies mirrored republican pretensions. Yet new sites of exposure, in the mills and in urban crowding, seemingly magnified the dangers facing to the ‘two-legged cattle stalled in our manufactories’. Beddoes’s remarkably prescient essay on the effects of manufactures reflects the emerging awareness of environmental illness brought on by irritating chemical substances in a rapidly industrializing Britain. Diseases did not make distinctions of class or occupation. As Beddoes pronounced, ‘If we raise our view from the lower to the higher classes, we shall here perceive that it is upon the lilies of the land, that neither toil nor spin, that the blight of consumption principally falls.’ His vision dissipated in many a disappointment. As Beddoes put it, he ‘must expect to be decried at home as a silly projector, and by others as a rapacious empiric.’

For the many subjects, whose traces now barely exist, there was an immense hope that evaporated as certainly as did the airs. Take the dire case of the surgeon and apothecary George Crump, of Albrighton in Shropshire. This obscure country medic had watched his son die of consumption. Even so, he told Beddoes in 1793, ‘I am very well satisfied, that if your method of living with the free use of mixed air has been entered upon sooner, we should have saved him.’ Crump recounted how his son ‘used frequently to ask me for some of Dr. Beddoes breath—for the little he had was almost gone’ for want of a proper apparatus. To Erasmus Darwin, Beddoes privately demurred, ‘I do not know whether you will allow the circumstances of this case offered a reasonable inducement to prosecute this method of treating consumption.’ In an epidemic of consumption, as Watt and Beddoes had ample reason to know, pneumatic chemistry held out fleeting hope for some of His Majesty’s most desperate subjects.

NOTES

3 British Library, India Office Records, G/12/90, f. 192r: Charles Cathcart to Sir Richard John Strahan, 28 May 1788; Strahan, Journal of the Proceedings of His Majesty’s Ship Vestal. Between the 22d December 1787 and the 9th October 1788, fols 221–222, 16 June 1788.


15 ‘Case communicated by Dr. Parry, of Bath’, in Beddoes, *op. cit.* (note 4), p. 43; on Parry, see also Neve, *op. cit.* (note 8), p. 39.
23 BCL, JWP C1/15: James Watt to James Lind, 28 September 1783.
24 BCL, JWP 4/22/45: Ewart to Watt, 5 October 1794.
33 Cornwall Record Office, Davies-Gilbert MSS., DG 42/1: Beddoes to Davies Giddy, 31 October 1794.
34 BCL, JWP 14/65/13: Thomas Henry to James Watt, 6 December 1794.


42 Beddoes, op. cit. (note 37), pp. 220–222.


44 Beddoes and Watt, op. cit. (note 37), pp. 137–138. Thornton to Beddoes, 1 August 1795. Crawford was a member of the Chapter Coffee House Society, which had extensive connections among the chemists. See Trevor Levere and Gerard L'E. Turner, *Discussing chemistry and steam. The minutes of a coffee house philosophical society 1780–1787* (Oxford University Press, 2002).

45 Beddoes, op. cit. (note 4), pp. 24, 35.

46 BCL, JWP 4/65/5: Thornton to Watt, 13 July 1795.


48 BCL, JWP 5/65/7: Beddoes to Watt, 12 December 1794.

49 BCL, JWP 4/65/5: Thornton to Watt, 13 July 1795.

50 BCL, JWP W/9/56: Cleghorn to Watt, 12 May 1796.

51 BCL, JWP W/9/42: Seward to Watt, 24 August 1796.

52 BCL, JWP W/9/38: Seward to Watt, 28 September 1796.

53 BCL, JWP W/9/19: Beddoes to Watt, 24 October 1797.


57 Beddoes and Watt, op. cit. (note 37), pp. 41–42.

58 BCL, JWP W/9/9: Partington to Watt, n.d.


63 Thomas Beddoes, A Letter to Erasmus Darwin, M.D. On A New Method of Treating Pulmonary Consumption, and Some other Diseases hitherto found Incurable (Bulgin & Rosser, Bristol; J. Murray and J. Johnson, London, 1793), p. 3.