Chapter 1 Workers get ill – but can anything be done?

Workers get ill

In 1705, the Parish Clerk of Ubley, at the foot of the Mendips in Somerset, broke into mournful verse as he recorded the death of a villager in the parish register. The clerk wrote that John Dirrick's
"constant employment was under ground,
his long distemper was shortness of breath"
until after a life "in labour and forever in grief and pain", he "surrendered his soul to God again".[1]

John Dirrick was a lead miner, and the health problems in that industry were well known (Fig 1.1). Later in the century Dr Johnson wrote in his famous dictionary that the smoke from the Mendip lead works was a "prodigious annoyance" and caused "mortal disease".[2] But the special thing about John is that he is the first individual we know by name as having suffered from an occupational disease in Britain.

Fig.1.1. These bumps and hollows in the hills near Charterhouse, Somerset, are partly the remains of old lead mining. This is about 4 km SW of Ubley, where John Dirrick worked and died as a miner. Photo by Neil Owen. Creative Commons Licence. https://www.geograph.org.uk/photo/5235936

Of course, John had many predecessors who had died with occupational diseases whose names we do not know. We shall see in a later chapter how making flint tools, or shaping flint or sandstone for building, can lead to silicosis. Manual work, including working the land to grow food for your family, can lead to crippling disease. The palaeopathologist Calvin Wells looked at over a hundred skeletons in the 10th century cathedral cemetery at North Elmham, and found that by their mid-20s over 90% of the people showed signs of skeletal changes, often painful (Fig 1.2) which would be brought about by the stresses and strains of manual work on the land or in hewing and carrying.[3] [4] Of course, we are mainly interested in prevention, so it is interesting that Wells attributes the many cases of osteoarthritis of the feet to agricultural work on heavy clay with inadequate footwear.

People have realised for thousands of years that work caused disease, and some suggested treatments, but what about those, our predecessors as occupational hygienists, who tried to do something about it by making working conditions better? They included physicians, engineers, and mechanics, even perhaps boot-makers, and of course the workers themselves. The recognition and assessment phases were not formalised, but they saw the problem, drew conclusions about the cause, and took some steps to do something about it, and in most cases their efforts were applied locally and are not recorded. This must have gone on a long time, but four steps in the decades around 1700 make that a good time to start this survey of British occupational hygiene.

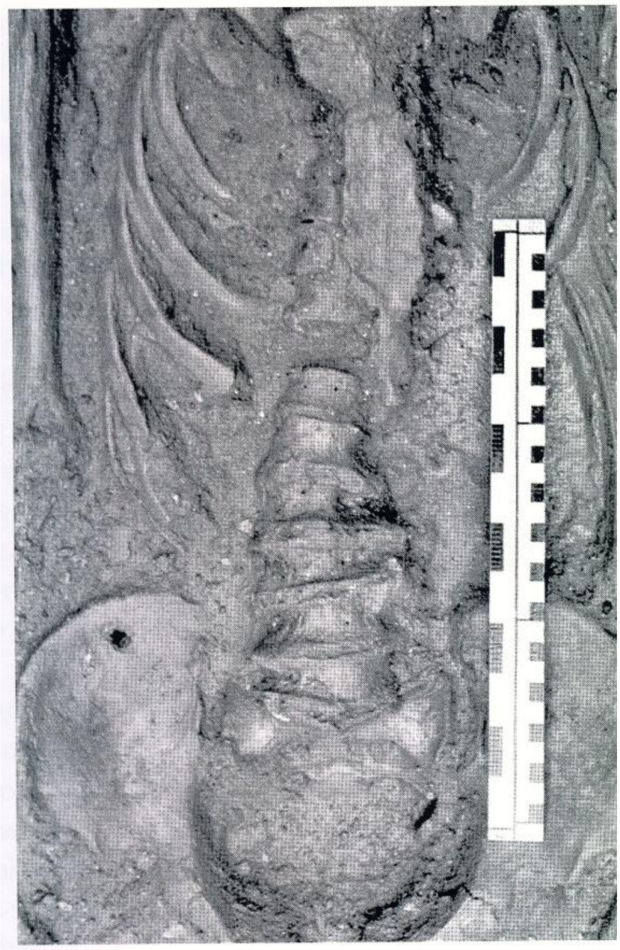


Fig 1.2. Part of a skeleton from the 10th century cathedral cemetery at North Elmham, Norfolk, showing distortion of the lower vertebrae, attributed to heavy labour, and seen in people in their 20s. Photo courtesy of Peter Wade-Martins (see ref 4)

Step 1. Recognising the diseases

One physician who looked widely into causes and had a long influence on occupational medicine in Britain and elsewhere was an Italian called Bernardino Ramazzini who about the time of John Dirrick's death published *De Orbis Artificum Diatriba* ("The Diseases of Workers"), describing the working conditions of an astonishing variety of trades, and the diseases which they caused, often after a short exposure.[5] Ramazzini (Fig 1.3) looked into the detail of a world of work which polite society ignored, but on which it depended: privy cleaners, pall-bearers, printers, starch processors, silk dressers, sifters of grain, salt-workers, scribes, sailors, soap-makers, wood-workers, well-diggers, wet-nurses, and many others, and he wrote about them with sympathy. In mining, he recognised the twin hazards of inhaling "vapours and toxic dust particles", and "the violent and unnatural movements that impair the very structure of the body". In doing so he recognized two classes of hazard which have run through occupational disease: external agents, and the rigours which the body and mind have to face to do the work. However, Ramazzini's focus was on what could be given to sufferers to relieve their inevitable sicknesses; he had little to offer on protection, other than averting the head from fumes, covering nose and mouth with a handkerchief to avoid dust, and washing body and clothes afterwards. At that time and for another two hundred years disease was usually seen as a necessary consequence of work, which generally had to be accepted, and with only fairly primitive methods of avoiding disease, of which the most obvious were ventilation and personal protection.

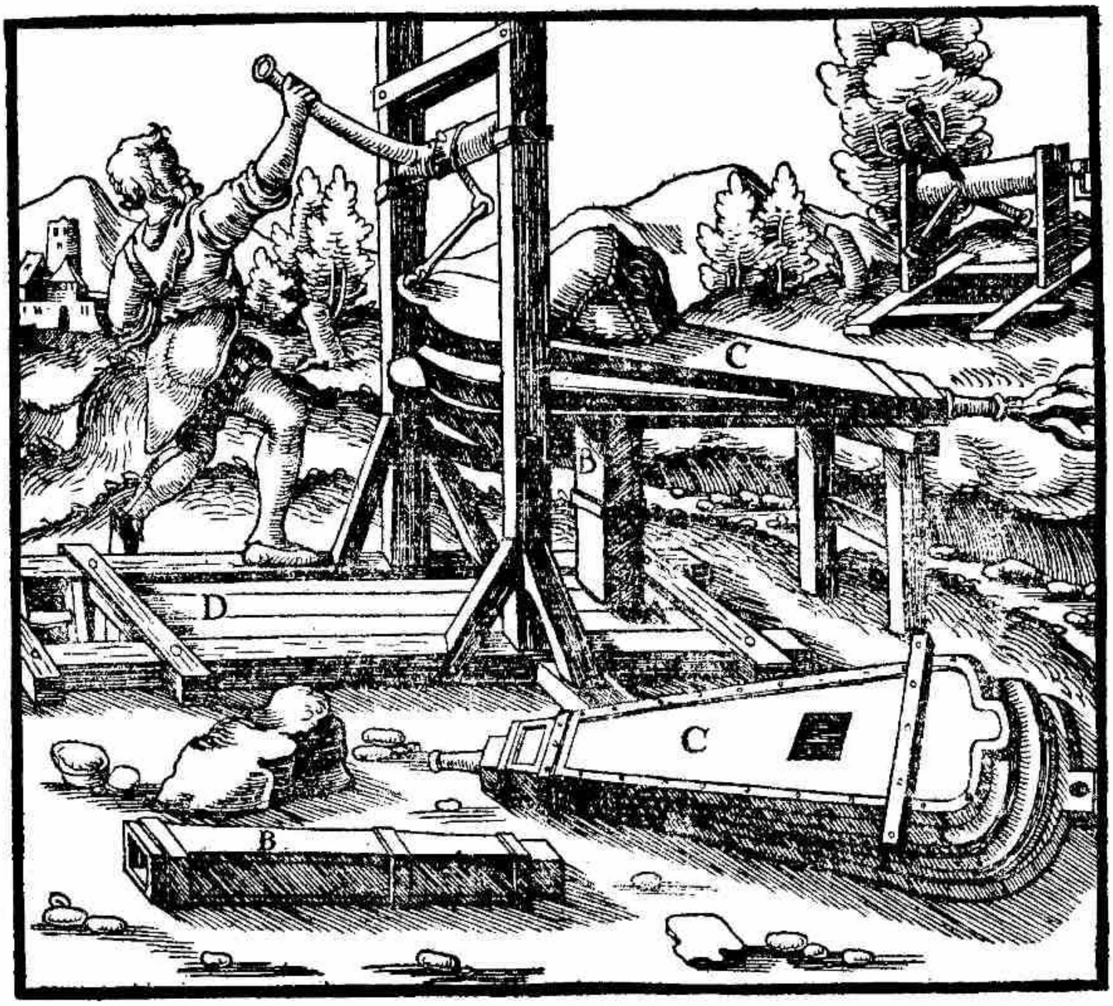
Step 2. Applying ventilation

Ventilation and personal protection must have been obvious from antiquity as preventive measures. Georg Pawer (Bauer in modern German, and Latinised as Georgius Agricola) was a broadly-educated physician who between 1527 and his death in 1556 had a series of posts in the area around the present-day borders of Germany and the Czech Republic - so about 150 years before Ramazzini. Agricola wrote a detailed treatise on mining, *De Re Metallica,* and gave details of systems of ventilation which tried to provide breathable air hundreds of metres from the surface.[6] A simple technique was to build a wooden structure at the top of the shaft to divert the wind into the mine. More complicated structures were enclosed fans and bellows, which could be operated, by men, horses, or wind or water power, to draw foul air out along wooden pipes, so that clean air would enter along the tunnels and replace it (see Fig.1.4). The area where Agricola worked then led Europe in mining, and some workers from there were brought to England in Elizabethan times, so similar techniques may have been introduced here.[7]

Fig 1.3. Bernardino Ramazzini (1633 – 1714), who was concerned about diseases of soap-makers, wood-workers, well-diggers, wet-nurses and many others, but could do little to prevent them. Picture: public domain.

The first British records of deliberate ventilation of mines seem to be from the late 1600s. In 1665, Sir Robert Moray described a somewhat similar device to Agricola's which he had seen in use in what is now Belgium, but in this case the pipe from the workings provided the air-supply for a furnace with a high chimney. This should have provided an effective way of drawing air from the pit, so that clean air would be drawn in to replace it, and was obviously much better than depending on the physical effort of the operator.[8] Alternatively, having two shafts into a mine can provide improved ventilation if a through draft can be induced. This could happen if the air in the mine was at a different temperature from outside and the two exits were at different levels. A fire could be used to increase the flow. In 1686 Robert Plot, who was Professor of Chemistry at Oxford, described how in a Staffordshire mine an iron cradle containing a fire was lowered into one to the shafts to produce the through flow,[9] so that has the distinction of the first recorded control measure applied in Britain. Plot recognised that the gases in the mine could either asphyxiate (eg, as we now know, by carbon dioxide), poison (eg, by carbon monoxide), or explode (methane). Georgius Agricola was also aware of the additional longer-term problem for miners, that “sometimes their lungs rot away “, but apparently he did not know this was caused by dust.

So all of these techniques and learned insights predated John Dirrick’s death in the Mendips, but we do not know if any were applied there. Lead sulphide ore is very insoluble, so may not have been much of a hazard itself. The general dusts in the mine would have been damaging, and the more soluble lead compounds produced by lead smelting certainly would have been. In his 16th century treatise, Agricola describes smelting at length, but as far as I can see he does not say anything about protection.



A—Smaller part of shaft. B—Square conduit. C—Bellows. D—Larger part of shaft.

Fig.1.4 One of Agricola’s devices for drawing “foul air” out of a mine. The bellows C draws the air out of the mine through pipe B, and clean air goes down the shaft D to replace it. This system clearly depends on a fit and committed operator.

Step 3. Personal protection

Agricola did however write about the use of personal protective equipment in mining, including the importance of protecting the hands and legs against acidic mine water. On respiratory protection, he says that the miners "should fasten loose veils over their faces; the dust will then neither be drawn through these into their windpipes and lungs, nor will it fly into their eyes." There is however a much earlier record of respiratory protection overseas. Pliny the Elder, who died in the eruption of Vesuvius in AD79, wrote amongst many other things of the process of preparing minium, a pigment which could either be made of red lead (Pb_3O_4), or of cinnabar (HgS), both of course hazardous Pliny says in his *Natural History*, "Persons employed in the manufactories in preparing mimium protect the face with masks of loose bladder-skin, in order to avoid inhaling the dust, which is highly pernicious; the covering being at the same time sufficiently transparent to admit of being seen through."[10]

In Britain, underground mining had been going on since Neolithic times for flint and since the Bronze Age for copper and tin, and continued in many places through Roman times and the Middle Ages. No doubt miners in this country protected themselves as best they could, but as with ventilation, we do not know for certain if any of Agricola's or Pliny's methods were used here.

Step 4. Control at source

At the beginning of the 18th century, there was a growing pottery industry in Staffordshire, and it was discovered that adding up to 50% of calcined flint to clay produced a pottery with enhanced strength, whiteness, and dimensional stability during firing. We now know that flint is a form of crystalline silica, about 99% pure; calcining, that is heating to around 1000°C, produced a whiter flint which could be more readily crushed to a fine powder in large iron mortars. The fine powder was then passed through hair sieves. The process was mechanised, and spread in the potteries area round Stoke on Trent, but the problem was that inhaling the powder quickly produced fatal disease, which we now recognise as silicosis, and there was a rapid increase in the number of cases in those "exposed to the baneful effects of the dry and impalpable dust which floated round them as they worked". These are the words of Eliza Meteyard, who relates the story in her *Life of Josiah Wedgwood*,[11] and tells how a decorator from London called Thomas Benson was painting at nearby Trentham Hall, heard of the problem, and thought that the process used for grinding colours might be adapted. He borrowed money, tried the process, and in 1726 was granted a patent for wet grinding of the calcined flint. The patent was described and illustrated in *an Annals of Occupational Hygiene* paper by Tim Carter in 2004.[12] The process involved first wetting and then grinding the calcined flints between iron "millstones"; this produced a sand-like powder. The powder was transferred to an pan, where the powder was crushed further under water by rollers or stones, pushed round by a paddle-wheel-like structure rotating round a vertical axis and powered by a water wheel (see Fig 1.5) . The pan had a hard chert floor, and the stones were of a slightly softer chert, so wore away quicker. The slurry of powdered flint could then be drawn off.

Fig 1.5. Grinding mills like those described in Benson's 1726 patent, at the Etruria Industrial Museum, Stoke on Trent. These mills can be seen in operation on a YouTube video, https://www.youtube.com/watch?feature=player_embedded&v=vUZD5XmBNJY.

Benson's process was therefore an early – perhaps the first – example of a wet process being substituted to prevent dust getting airborne, permitting a very useful industrial advance in pottery without an increase in risk. However, according to Eliza Meteyard, Benson never recovered the money he had put into the development, and died in poverty. Professional societies in occupational hygiene have named their awards to commemorate their pioneers. It is high time that the memory of Thomas Benson was honoured in this way.

Despite the work of Benson and others, silicosis in pottery making remained a serious problem until the middle of the 20th century, with 40 to 50 cases a year in the 1940s. Crushed flint was not only used in the clay, but to support pots in firing. The disease was finally dealt with by substituting alumina for silica.[13]

By 1800, then, the obvious measures of general ventilation and respiratory protection were used , and wet grinding had reduced the risk in at least one industry, but mechanisation was growing fast, and often meant more hazardous material in the air, no doubt more noise, and undoubtedly more accidents. There will be more on this in chapter 2.

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[1] See Ogden T, Ann Occ Hyg 49 (8): 647 (2005). https://doi.org/10.1093/annhyg/mei056

[2] Johnson's Dictionary (1755) http://johnsonsdictionaryonline.com/lead-noun-1/

[3] Wells C, Cayton H. 12. The Human Bones. In *Excavations at North Elmham Park 1967-72,* by Peter Wade-Martins. East Anglian Archaeology 9 (pt 2) pp 247-302.Norfolk Museums Service, 1980. http://eaareports.org.uk/publications/page/17/

[4] Wade-Martins, P. *A life in Norfolk's Archaeology, 1950-2016.* Oxford, Archaeopress Publishing, 2018

[5] A modern English edition is in Ramazzini, Bernardino, *Works, Vol 1,* Transl Cawthra C; Ed Carnevale F, Mendini M, Moriani G, Blanc P, Slack RS. Verona, Cierri Edizioni, 2009

[6] Georgius Agricola, *De Re Metallica,* 1556. Translated by Herbert C and Lou H Hoover, Dover Publications, 1950. Book 6. http://www.gutenberg.org/files/38015/38015-h/38015-h.htm

[7] Hudgkins CC, Martinón-Torres M, Rehren T (2009) From the mines to the colonies: archaeological evidence for the exchange and metallurgical usage of English copper in early seventeenth century Ireland and Virginia. https://www.academia.edu/4009982

[8] Moray R (1665) An account, how adits and mines are wrought at Liege without airshafts, communicated by Sir Robert Moray. Phil Trans 1(5):79-82

[9] Plot R, *The Natural History of Staffordshire,* pp 134-139. . Oxford University, 1686. https://books.google.co.uk/books?id=T03JVJkdC9gC

[10] Pliny the Elder, *Naturalis Historia* (AD 79). Available as "The Natural History", transl by John Bostock (1855). Book 33, ch 40 http://www.perseus.tufts.edu/hopper/text?doc=Perseus%3Atext%3A1999.02.0137%3Abook%3D33%3Achapter%3D40

[11] Meteyard E. *Life of Josiah Wedgwood,* Vol 1, ch IV, pp146-153. London, Hurst and Blackett, 1865. https://books.google.co.uk/books?id=bYRAAAAAYAAJ&pg=PA131

[12] Carter T, British Occupational Hygiene Practice, 1720-1920, Ann Occ Hyg 48 (4): 299-307 (2004); https://academic.oup.com/annweh/article/48/4/299/145303

[13] Meiklejohn A, Silicosis in the Potteries: Some observations based on seven hundred and fifty necropsies. Brit J Ind Med 6 (4): 230-240 (1949) https://www.jstor.org/stable/27720778?