REMARKS

ON

BRASSWORKERS' DISEASES:

BEING A THESIS FOR THE DEGREE OF M.D. IN THE
UNIVERSITY OF CAMBRIDGE.

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THIS subject is one of the greatest interest to those who live in manufacturing towns, such as Birmingham, where large numbers of men are employed in the brass trade. That brassworkers are exposed to unhealthy conditions is fully recognised by the men themselves, as well as by their employers, who speak of the trade as a most unhealthy one. Brassworkers rarely attain old age, and formerly provident sick societies either altogether refused to enroll them on their lists, or accepted them as members at greatly increased rates.

The recognition of working in and making brass as causative of disease is due to Dr. Headlam Greenhow, who, in 1862, read before the Royal Medical and Chirurgical Society a paper on Brassfounders' Ague. This was based on his experience gained while paying a brief holiday visit to Birmingham in 1858, in connection with his investigation of trades injurious to health. It is curious that he should have selected for his title the name of a disorder which undoubtedly occurs, but which, as I shall endeavour to show, is only an acute expression of a chronic disease, and one which rarely or never comes within the range of experience of practising physicians.

In the out-patient departments of the Birmingham hospitals one meets with an enormous number of brassworkers complaining of various pulmonary and gastric disorders; but in over eight years' experience among over 30,000 patients, I have never yet been consulted by anyone in the matter of this so-called ague, although questions will very frequently elicit the statement of its occurrence.

The literature of this subject is very scanty, but Greenhow quotes Thackrah's essay on the *Effects of Arts, Trades, and Professions on Health and Longevity*, published about 1830, as well as the writings of a few Frenchmen, who have not, however, materially advanced our knowledge of the disease. Thackrah's observations were clearly inaccurate and imperfect, for he mentions only "ague," which he speaks of as an intermittent fever, attacking brassworkers from once a month to once a year, and leaving them in a state of great debility.

Dr. Hogben, Physician for Out-patients at the Queen's Hospital, Birmingham, published a very interesting paper on this subject in the *Birmingham Medical Review* in May, 1887. Dr. Greenhow refers only to ague and bronchial disorders, and very cursorily to nervous troubles, as resulting from brass-casting; but Dr. Hogben mentions also the colic, constipation, and dyspeptic troubles which result from this occupation. Dr. Greenhow, on the one hand, refers all the symptoms to intoxication by zinc, while Dr. Hogben thinks they should rather be referred to chronic copper poisoning. These two metals are the principal ingredients in the making of brass, which needs a brief description.

Copper is put into crucibles, which are plunged into a sunken furnace, and covered in order to exclude the air. When the copper is melted, the crucible is removed, and zinc—about 30 per cent.—and small quantities of lead, tin, and brass dust are mixed with the molten copper, which is hot enough to melt them. When the whole mass is molten, it is poured into moulds called sows; during the pouring the zinc deflagrates, and a dense white smoke is formed, which almost instantaneously fills the atmosphere of the casting shop. This smoke is rapidly converted into snow-white flakes and white powder, consisting of the oxide of zinc, which remains for some time diffused through the atmosphere of the shop, and, in ill-ventilated casting shops, collects upon the rafters and ceiling in the form of a dense white incrustation. The quantity of these fumes depends, first, upon the amount of zinc employed; secondly, upon the ventilation of the casting shops; and, thirdly, upon the weather—a dull foggy day preventing their

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escape. The shops in newly-erected factories are only one story high, and have large sliding panels in the roof to permit free escape of the fumes, but in the older buildings they sometimes have other rooms above them, and free ventilation is impossible. It is a matter of experience that workers in ill-ventilated shops suffer much more from ague and bronchitis than those who work in the better buildings. The men who do this work are called mixers, and protect themselves to some extent by tying handkerchiefs over the nose and mouth to prevent as far as possible inhalation of the fumes. From the mixers the work goes to the casters or founders, who remelt the pigs of cold brass, at a lower temperature than is required for melting copper, and pour it into the sand moulds, which are faced with a fine powder of loam, charcoal, coal, and bean flour. From this powder rises a dense cloud of dust, and from the molten metal a cloud of zinc oxide, though not so much as in the mixing shop. Founders suffer principally from bronchitis, or asthma as they call it, and ague, though in a lesser degree than the mixers. From the casters the work goes to the warehouse, where it is sorted and sent to be polished, or dipped and bronzed.

By the polishers, emery, fine sand, lime, and rouge are used on rapidly revolving brushes, or wooden wheels faced with leather. From these considerable dust is given off, and bronchial troubles are caused; but "ague" does not affect the polishers.

The dippers work under a shed open on all sides to the air, and immerse the brass in a weak solution of sulphuric acid; it is then dipped into water, then into a stronger acid solution, again into water, once more into acid, then into a solution of soda, finally into pure acid, and washed in water. There are always exhalations of acid, and in warm weather these are especially troublesome. It is noteworthy that, though dippers do not suffer from ague or intestinal troubles, their occupation is considered by masters and workmen alike to be the most unhealthy of all, on account of the great bronchial irritation from the acid fumes.

From the bronzers the work is sent to the lacquerers, who are nearly always females, and suffer nothing from their occupation. From them it goes to the dressers to be fitted, and finally to the warehouse.

It will appear from this account of the process, that those who deal with the molten metal are the only ones to suffer from brass ague, while they, as well as those occupied in shops where there is much dust or acid fumes, are liable to bronchitis and asthma. Moreover, all brassworkers except dippers and lacquerers are subject to colic, constipation, and various other disturbances of the gastro-intestinal system.

That Thackrah was in error in speaking of brass-ague as an intermittent affection, occurring once a month or once a year, is clearly proved by the following positive observation, which is supported by all brassworkers. Ague never occurs among the regular workers, but always affects those who are new to the work, or who resume work after an absence of even a month or a fortnight. If a man resumes work, that is, melting or casting, after ever so brief an interval, he is sure to have an attack of ague; but he will have only one attack, and remain free until after his next holiday. There is most certainly no kind of regular intermission, and, according to brassworkers themselves, they only suffer until they are injured to the poison.

The following are the symptoms of this so-called ague: after working a few hours, a man becomes languid, depressed, and feels very cold. He is very pale and almost in a state of collapse, his face is covered with a cold perspiration, he shivers, his teeth chatter, and he is restless and anxious. His head aches, there is much nausea and complaint of muscular pains. As a rule he goes or is led home, where he drinks freely of milk and goes to bed. The symptoms continue until he has vomited, either as the result of taking an emetic or independently of it. Vomiting is usually followed by sleep or recovery, with more or less of debility and lassitude on waking.

Drs. Greenhow and Hogben speak of a more or less marked hot stage following the cold, and following the hot stage they mention profuse sweating. The hot stage may be absent, but the sweating, according to these writers, invariably occurs.

My own observations, based on inquiry amongst those who have suffered from this ague, have never elicited a statement of these hot and sweating stages. Even direct questions as to their occurrence have always been met with positive negation, though some have spoken of free perspiration in the stage of collapse. How to reconcile these statements I do not know.

The cycle of events, as recorded by Greenhow, is just that of

ordinary ague, from which this disease differs, otherwise than in the suggested sequence of symptoms, *in toto*. The inquiries I have made do not support such a sequence, and certainly not a relationship to malarial ague. The symptoms are just such as would be caused by the ingestion of a quantity of an irritant metal, sufficiently large to cause vomiting and its attendant depression. Such, indeed, is my opinion of the causation of the symptoms, and therefore the name "ague" should not be continued, as being wrongly suggestive and misleading.

It will be remembered that it is only when fresh to the work that brassworkers suffer from "ague;" but, though they do not suffer from acute metallic poisoning, they do suffer from its chronic effects, and it is extremely probable that, as with arsenic and opium eaters, they may become inured to the use of the metals. It is not very common for brassworkers to use tooth-brushes, and the accumulating tartar will be found coloured green. If every effort be made to cleanse the teeth, there will yet be generally green discoloration of them. This has been proved to be due to the presence of copper. White hair is often coloured green among these workmen, and the underclothing is often stained green by the perspiration. The gums may be slightly blackened at the edges, but there is nothing distinctive as in the case of the blue line of lead poisoning; nor, indeed, beyond the green colouring of the hair and teeth, do brassworkers present any unequivocal evidence of their calling.

Ague is not a disorder for which brassworkers consult a medical man; they know how to treat it themselves, and also that it is transitory in its effects; but they come to hospitals in large numbers to be treated for bronchitis. About this there is nothing special. They suffer from it in common with all workers in dusty trades; and, so far as I can learn from the secretary of the Brassworkers' Organisation, they usually die from chronic bronchitis or fibroid phthisis, unless they succumb to some acute malady.

The existence of nervous disorders, especially paralysis agitans, has been said to be common amongst them, but I cannot find that a larger percentage of brassworkers than of the rest of the community suffer from diseases of the nervous system. It is common, however, amongst them to meet with complaints of disturbance of the digestive function. They suffer from dyspepsia, loss of appetite, gastro-intestinal catarrh, nausea, vomiting, metallic taste, thirst, colic, constipation, and diarrhoea. They are often nervous and hypochondriacal, complaining of headache and muscular pains. There is nothing distinctive about any of these disorders, except the obstinacy with which they resist ordinary methods of treatment, and the readiness with which they yield to the administration of iodide of potassium in combination with the other drugs indicated by the various conditions of ill-health. All the symptoms bear a remarkable resemblance to those produced by chronic copper poisoning, and in Guy and Ferrier's *Forensic Medicine* an outbreak of copper poisoning from the use of copper vessels in cooking is recorded, in which the symptoms were almost identical with those here mentioned.

The inmates of a convent suffered severely from obstinate and severe colic, retching, and bilious vomiting, costiveness and flatulence, burning pain in the pit of the stomach and extremities, and paralytic weakness in the arm. According to Stevenson, it is impossible to distinguish between the symptoms produced by zinc and copper poisoning; these are just such as brassworkers suffer from, and it is therefore impossible to say which metal—copper or zinc—is most concerned in the production of these symptoms.

Dr. Greenhow attributes them all to the inhalation of the de-flagrating zinc; this forms zinc oxide, which is only sparingly if at all soluble, and therefore is not likely to be freely absorbed in the stomach; but he pays little or no attention to the common and chronic gastric and intestinal troubles to which brassworkers are liable. These affect all those engaged in the various processes by which either in vapour or in minute particles copper and zinc—that is, brass—are distributed in the atmosphere.

Dr. Hogben, on the other hand, considers copper alone to be the efficient cause of the symptoms, and advances the following arguments:

1. We have no evidence that the internal administration of zinc ever produces the symptoms of brass-ague. Enormous doses of the oxide have been administered without apparently producing the characteristic febrile reaction of brass-ague.
2. The malady is observed in individuals whose work is other than casting.

3. The malady is not observed in operatives such as galvanised ironworkers, who work with zinc and are exposed to its fumes.

4. Zinc is rapidly excreted, and does not, like lead, mercury, or copper, become fixed in the body, and produce chronic affections.

It seems more probable that, accepting Stevenson's statement of the impossibility of distinguishing between the effects of acute copper or zinc poisoning, the symptoms of ague are due to an admixture of the two metals, whereas for the chronic complaints the copper is responsible.

How the practice of taking milk during an attack of so-called ague has arisen is not clear, but its wisdom is proved by the fact that in cases both of copper and zinc poisoning, milk is one of the best antidotes, since it precipitates both these metals into insoluble albuminates.

It is abundantly evident that brassworkers are specially liable to diseases from the use of the metals employed in its manufacture, but they are not new disorders; they are either proofs of chronic poisoning by zinc or copper, or as in the so-called ague, are due to intoxication by them.

For much of my information as to the effects of this work I am indebted to Mr. Lilly, the local secretary of the Brassworkers Association.

ON TESTING THE COMPETENCY OF THE VALVES OF THE HEART BY MEANS OF AIR.

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THE ordinary method of testing the competency of the valves of the heart with water is admittedly faulty in many respects. It can be applied only to the aortic and pulmonary artery orifices, and even with them the pressure of $1\frac{1}{2}$ to 2 inches of water, which alone can be retained in the attached portions of the vessels, does not represent anything like the pressure to which they are naturally subjected. Hence a valve which during life might have been sufficiently incompetent to give rise to a murmur, may be found after death to be perfectly competent. The water method is also defective from the fact that the cusps of the valve are not seen in motion, so that the mechanism by which a murmur may have been elicited is incapable of being demonstrated in the *post-mortem* room. We possess, moreover, no exact method of gauging the amount of incompetency of the mitral and tricuspid, nor of ascertaining when they are competent.

For some time past I have been in the habit of demonstrating to my class the natural action of the valves by driving air into them instead of water, and also of reproducing the murmurs heard in disease of the valves by several simple modifications of the same method.

The ascending aorta with the attached valve is cut off from the heart of an ox. A brass tube attached to a bellows is introduced into the distal end of the aorta. The aorta is now fixed in as nearly as possible its natural position, and air is driven in from the bellows with a sharp click, so as to imitate as closely as may be the effect of the arterial recoil. With each inflation of the bellows the cusps are retracted, to be closed again as soon as the air is expelled; and so perfect is their adaptation, even after death, that not only do they prove perfectly competent when the heart is healthy, but the sharp sound elicited bears a remarkable resemblance to the second sound of the heart. The valve can be turned up in any position, so as to be made readily visible to a whole class.

The same means may be employed to display the action of the pulmonary artery valve. In the case of the mitral and tricuspid, the respective auricles should be cut away close down to the orifices. The nozzle is pushed down through the aorta or pulmonary artery, as the case may be, past the valve, so that it enters well into the cavity of the ventricle. It is tied into the vessel so as to prevent regurgitation of the air.

It struck me that the same means might be utilised for testing the competency of the valves in the *post-mortem* room; and, having employed the method lately in a number of cases, I find that it works admirably. It can be applied almost as quickly as the water test, and has the great advantage of being available for all the orifices.

The procedure I adopt is the following. An opening is made into the left auricle, so as to expose the auricular aspect of the