excessive overgrowth of cartilage. The parts removed extended wide of the growth. The patient made a satisfactory recovery from the operation and was quite well for nearly a year. She wore a metal shield covered with wash leather to protect the cardiac region where the natural bony and cartilaginous covering was missing.

The patient is still living, but is suffering from recurrence of growth in the chest wall too extensive for removal.

These cases serve to show that it is quite safe to remove even a considerable portion of the pericardial walls, and that the gap in the fibro-serous sac can be efficiently covered in by a flap taken from the pectoral muscle.

The apparent limitation of growth in both cases and its seemingly complete removal gave hope at the time that operation might be completely successful.

Had it been possible to know the nature of the growth before removal in the first case it would have been recognized as hopeless, since carcinoma of the ribs is a secondary affection, though curiously the primary disease was never found, either when the patient was under my observation or during the later months of life.

The encapsulated nature of the sarcoma in the second case and its apparently complete removal made the recurrence a year later a matter of great disappointment to every one concerned.

Although the actual operation in these two cases was attended with immediate success, the after-progress of the cases was not such as to make one desirous of repeating what was necessarily a very anxious procedure; both for surgeon, anaesthetist, and patient.

I have related these cases from a sense of duty rather than as an example to be followed, and because I think it is an interesting fact worthy of note that the pectoral muscle seemed to answer perfectly as a substitute for the deficient pericardium.

THE SULPHUR MINERS OF SICILY: THEIR WORK, DISEASES, AND ACCIDENT INSURANCE.

By **SIR THOMAS OLIVER, M.D., LL.D., D.Sc., F.R.C.P.,**
JOINT PROFESSOR OF THE PRACTICE OF MEDICINE IN THE UNIVERSITY
OF DURHAM COLLEGE OF MEDICINE, AND PHYSICIAN TO THE
ROYAL VICTORIA INFIRMARY, NEWCASTLE-UPON-TYNE.

In the spring of 1910 I visited Sicily, with the object of studying upon the spot the conditions under which sulphur mining is carried on, and its effects upon the men and boys employed. I was the guest of Dr. Alphonso Giordano of Lercara, a gentleman whose professional life has been spent amongst the sulphur miners, and who is regarded as the greatest authority on the diseases of the mining classes. Unusual opportunities were thus afforded me, not only of descending into the mines and of seeing the men and boys at work, but of discussing with Dr. Giordano and mine managers what steps should be taken to improve the conditions under which the work is carried on. On my way to Sicily, in passing through Rome, I had an audience of the Prince de Scalia, Under Secretary of State, who was kind enough to ask me to favour him with a report upon the sulphur miners and their work, accompanied by such recommendations as I thought fit to make. This request was subsequently complied with.

Lercara is situated in one of the sulphur-bearing areas near the centre of Sicily. On our way from the station we passed carts laden with large blocks of sulphur, mules carrying similar loads, and near Lercara a few worked-out mines. In consequence of several of the mines having become exhausted, and partly, too, in consequence of American competition, sulphur mining in Sicily has not been prosperous during recent years. There are therefore fewer mines working in Lercara than formerly.

Many of the mines are in the hands of small proprietors, and in them the conditions under which the work is carried on are bad. They are not ventilated. The descent into these, as well as into even most of the large and partly ventilated mines, is by steps cut out of the rock. At one large mine there are 1,000 such steps. Immediately on entering the cave-like opening which leads into a mine the descent at once begins, and as many of the steps have become worn away, are irregular and broken, and have become greasy as the

result of the myriads of bare feet which have travelled down and up the steps, ingress and egress in the feeble light with which the mine is supplied are difficult and not free from danger.

In sulphur mines the men who bring down the ore, mostly by means of a pick, are known as *piconniers*; their work is carried on in a stifling atmosphere and in a high temperature. The exertion required is so great and the attendant circumstances are so trying—although the men work without any clothing—that they are obliged to rest after every fifteen to twenty minutes. I took the body temperature of the men, and found it slightly elevated—37.2° C. (99° F.), pulse rate 91, and respirations 28 to 34. The *piconniers* perspire freely, and drink from eight to ten pints of water daily.

The ore got by the men is carried on the shoulders of barefooted, scantily-clad boys up the steep and worn steps to the surface. As these *carussi* are not always given lights, the journeys up and down are made in the dark. Many are the sad accidents which have taken place owing to the *carussi* slipping. The boys and their burden roll down the steps, entangling in their descent other *carussi* who may be ascending. On coming out of the mine to deposit their burden of ore, these boys are seen to be panting for air, their breathing is quickened, and for the moment they are somewhat distressed. I found the respiratory rate of the *carussi* almost doubled—30 instead of 16—their heart beating at the rate of 128, and their temperature 38.1° C. (100.5° F.). The effect upon the boys of having to carry upon their shoulders such heavy loads of ore as 50 kilos, or a little over 110 lb., and frequently more, is seen in the undersize of the lads and the peculiar distortion of their spine. Formerly boys entered the mines at 7 years of age; now the age required is 12, but the law is not rigidly enforced. The *carussi* not only become hunchbacked and deformed in their legs, but worse; owing to the hard nature of their work, the inhuman treatment by the men, the long hours and monotony of their employment, mental development and physical growth do not keep pace with age, and as a consequence their manhood is arrested. In addition to the boys transporting the ore, the work is also done by men who commenced life in the mines as *carussi*, and who, as the result of having for years carried ore upon their shoulders, present a large hump on their back upon which the ore rests, a deflected spine, deformed lower extremities, and a distorted chest. So diminutive in stature are these men, and so deformed physically, that the Government can hardly obtain in a sulphur-mining district conscripts for the army. In going through the streets of a sulphur-mining town on a summer evening, or better on a Sunday when the men are all standing about, one is struck by the short stature and defective development of the men who transport the ore on their shoulders. Some of the men whom I measured, although 30 years of age and upwards, were only 4 ft. high, and in mental development were but as children. Partial or complete loss of vision is not uncommon among the miners as the result of injuries to the eyes.

The *carussi* are often harshly treated by the *piconniers* and by the men generally. Those who work in the small mines live at home or in lodgings, but at the large mines further away in the country the boys are housed with the men in barracks, the windows of which are barricaded during the day, so that sunlight never enters, and ventilation of the rooms hardly ever takes place. No females are employed to look after the rooms or bedding; men and boys feed together in a canteen, their food being bread, oil, and macaroni, with vegetables, dried beans, and lentils. The men have meat on Sundays, and they drink wine freely that day. So tired are the *carussi* and the *piconniers* after their ordinary day's work in the mines in the country away from the ordinary attractions of the towns, that they retire early to rest. A *carusso* pays 6d. a day for his food.

Sulphur miners work nine hours a day. The boys can make 1 franc a day, or a little more, according to age and physical fitness; the men carriers 1.80 francs, and the miners 3 francs. House rents are cheap in Lercara. One transporter whom I visited in his home paid 2 francs a month for his house; his wife had had eight children, four of whom were alive. The muscles of this man's back were enormously overgrown and the skin of the left

shoulder thickened. The *piconniers* do not reach a great age. They die from heart and kidney disease, partly owing to the hard nature of the work, and in some instances in consequence of excessive indulgence in cheap wine, half a pint of which can be obtained for less than a penny. This wine contains from 12 to 18 per cent. of alcohol. Considering the arduous nature of their work, it cannot be said that the sulphur miners are, on the whole, a drunken class. They have little time and less money during the week to spend in drink, but on Sundays many of them indulge freely.

Piconniers run all the risks to health attendant upon working in high temperatures; there occurs chilling of the body when perspiring, also bronchial irritation from exposure to cold and from inhalation of sulphur vapour. They are also liable to a form of fibrosis of the lungs, called *theapneumokoniosis*, the result of breathing an atmosphere laden with minute particles of mineral rock and sulphur.

Occasionally a fire breaks out in a mine, owing to firing of the sulphur dust by the use of ordinary powder or other explosives. The sulphur fumes are exceedingly irritating not only to the bronchial tubes, but to the eyes, hence the frequency of conjunctivitis amongst the men. This inflammation of the eyes is worse in some mines than in others. At the small mines no provision is made against fires, but at the Trabonelli mine, near Caltanissetta, the owners have a well-equipped store-room containing the Gelsenkirchen safety apparatus, as used in the Westphalian coal mines. Men are trained to wear this apparatus, and have drilling exercises every fortnight. On several occasions, when fires have broken out in the Trabonelli mine and the men had become overpowered by the fumes, they have been rescued by their comrades wearing the safety apparatus. Mr. Bassi, the manager, informed me that the apparatus had never gone wrong or disappointed him at a critical moment. During the drills the men wear the apparatus for two hours in the mine, and they do not complain of its weight. The employers have always at hand several cylinders of oxygen, also Bratt's oxygen automatic apparatus for the revival of persons suffocated by gas. At the Trabonelli mine there is an excellent first-aid department. It is managed by the Red Cross Society. There is a qualified surgeon, Dr. Vitrano, who wears the uniform of a military medical officer, with trained men to assist him. The society is a branch of the military service, and appointment in it carries rank. The surgeon is paid by the Insurance Syndicate, of which mention will be made later. Dr. Vitrano's assistants dress the wounds of the men. There are three rooms in the accident station. One assistant sleeps in the house, so that medical and surgical aid can be secured by day and night.

In addition to the presence of sulphurous acid vapour in the mines, sulphuretted hydrogen is occasionally met with, inhalation of which is extremely dangerous. At one of the mines eleven men lost their lives from this cause a few months previous to my visit. One lad who had been rescued and whom I examined had been unconscious for several days; he had been the subject of recurrent convulsions for weeks, and had also lost, but had regained, his speech. In a badly-ventilated mine, where the air is stagnant, the presence of sulphuretted hydrogen is a source of immediate danger to life. Added to the risks which I have already enumerated, the sulphur miners of Sicily occasionally suffer from ankylostomiasis, or the miners' worm disease. In this malady, health rapidly deteriorates in consequence of the parasite having gained an entrance into the small intestine, from which it extracts the blood of its host.

From Lercara I proceeded to the still more important sulphur-bearing district of Caltanissetta. Here there are 8,000 men and boys employed in the mines. The mines are large, and although the general conditions under which the work is carried on are better, they are still far behind Great Britain in matters relating to hygiene and care for the workmen. Although in some of the mines there are lifts for the ore, the miners have still to go down and have to climb up after a hard day's work several hundred steps. The men come out of the mine perspiring and often wearing nothing but a blanket thrown around their body. There are altogether about 40,000 sulphur miners in Sicily.

As already stated, the numbers have somewhat declined during recent years, and the output, which used to be 500,000 tons, has correspondingly diminished. Formerly 120,000 tons of sulphur were exported to America, but by the opening out of the mines of Louisiana and California this market has become closed to Sicily. At the time of my visit a ton of sulphur was selling for £4 10s. The land-owners receive a royalty of 14 to 16 per cent.

Where smelting of the ore is carried on the air for a considerable distance around the mine is impregnated with the vapours of sulphur, and vegetation is often blighted. The farmers occasionally obtain compensation for injury to their crops, the damage being assessed by an expert. This usually takes place in the early part of the spring, as once the crops become yellow no harm is said to be inflicted upon them by the sulphur vapour, and no compensation can then be awarded.

At Caltanissetta I had the opportunity of meeting M. Pompei Colojanni, the head of the insurance syndicate of the sulphur miners, to whom, as well as to M. Olivieri, owner of the Giona Sulphur Mines near Raculmuto, to M. Federo Caico, son of the distinguished authoress, and last, but not least, to Dr. Alphonso Giordano, my friend and host, as well as my fellow traveller through Sicily, I take this opportunity of tendering my warmest thanks.

My visit to Caltanissetta was largely undertaken with the object of having a conversation with M. Colojanni, to whose unremitting efforts the sulphur miners are indebted for the insurance fund, also for medical attendance and for the general and sympathetic interest which is taken in their welfare. The Sulphur Miners' Insurance Society is not a State-managed fund, although it is obligatory upon employers and leaseholders to contribute to it. The workmen do not contribute to the fund. The tariff is 2 francs per ton of melted sulphur. The amount of money raised from employers is 800,000 francs per annum. Of this, 250,000 francs are spent upon medical and surgical requisites, including payments to doctors and their assistants. The Red Cross Society receives a special allowance of 100,000 francs a year. There are in Sicily 112 medical men connected with the insurance society, but all doctors must, according to law, render first aid, if called upon to do so, and for this service they receive 7 francs. In Caltanissetta there is a consulting staff of 3 medical men, each of whom receives 3,000 francs a year. It is the duty of these medical men to visit the injured and to furnish a report to the director of the insurance fund. In 1909 over 2,000 medical visits were made.

The benefits of the insurance fund are only extended to men and boys who have been injured in, or in connexion with the sulphur mines, and to relatives of persons who have succumbed to injuries. If death supervenes after an accident, five years' wages are paid to the relatives of the deceased miner; the average amount paid is 3,000 francs, but this sum is regulated by the wages which had been received by the workman. Every injured miner is entitled to 2.40 francs per day. For ordinary sickness little provision has as yet been made; but in the event of an acute illness, such as pneumonia, employers will frequently render financial assistance to a sick miner, in the hope that, when he returns to work, deductions can be made from his weekly wages. To the establishment of the insurance fund there was considerable opposition on the part of the employers on account of expense; but a more beneficent scheme could hardly be conceived. It is now regarded by all as an excellent institution, one in which are highly reflected the foresight, ability, and humanity of M. Colojanni.

The syndicate has appointed three experienced inspectors to visit the mines and to offer suggestions to the owners as to the means whereby accidents may be prevented. These appointments have been productive of good. After every accident a report is sent to the State Mining Office, the Police, and the Insurance Fund. It is sufficient if the announcement is sent by telegram. In addition to the above there are also fourteen under-inspectors, who are paid by the fund to assist in a general way. These men frequently assist the surgeons in dressing wounds, etc. In the event of an accident proving fatal, a *post-mortem* examination is always made; this is attended by two medical men, one of whom is an official of the insurance fund, while the other is appointed by the magistrate of the district.

Since the establishment of the insurance fund, lawsuits, which used to number 200 a year, have fallen to 60. In 1905 the accidents numbered 9,000; in 1909 they had fallen to 5,000, owing to greater care, improvement of methods, and mine inspection. The period of temporary invalidity after accident used to be twenty-five days; the year before last it was sixteen and a half days. Injured miners receive pay from the first day of the accident. In consequence of the frequent visits of the official surgeons, whose report is final, malingering has been reduced to a minimum. An injured miner has one alternative, and that is to apply to a judge, who, if he deems it necessary, can send a doctor to examine the patient, and if the medical report is contrary to that of previous examiners, the judge may reopen the case and settle it. Lawsuits are tried in Caltanissetta and appeals are heard in Palermo.

The cost of the administration comes to 140,000 francs a year. The sum paid to injured workmen in 1905 was 700,000 francs; in 1909 it was 300,000 francs. M. Coloanni maintains that the terms arranged for the injured sulphur miners of Sicily are better than those for the ordinary miner in Germany.

The principal accidents are fracture of arms and legs due to falls of stone from the roof, fractures of the bones of the feet and injuries to the head by falls of stone. Beyond conjunctivitis due to irritation of the eyelids by sulphurous acid and sulphuretted hydrogen, eye affections are not common. Trachoma is sometimes met with. The men are occasionally asphyxiated through unexpectedly inhaling sulphuretted hydrogen and carbon dioxide gases given off from the bituminous clay and the naked lights used in the mine by the men and boys.

The *carussi* frequently fall down the steep and worn steps which lead into the mines. Of the 5,000 accidents which occur annually, 1,200 happen to these boys; 50 per cent. of the accidents occur among the *piconniers*, and 26 per cent. among the *carussi*. Of the latter 2 per cent. are fatal.

An Invalid Fund has been or is about to be opened for the sulphur miners. This will be managed by the State. To its owners and leaseholders will contribute 1.5 francs per ton of sulphur. It is stated that this fund will not be contributed to by the workmen.

Of the good results which have followed the introduction of the Accident Insurance Fund among the sulphur miners of Sicily I again repeat that I cannot speak too highly.

EXPERIMENTS ON THE RESTORATION OF PARALYSED MUSCLES BY MEANS OF NERVE ANASTOMOSIS.*

BY

ROBERT KENNEDY, M.A., M.D., D.Sc.,

SURGEON TO THE WESTERN INFIRMARY, GLASGOW, AND LECTURER ON APPLIED ANATOMY IN THE UNIVERSITY.

[ABSTRACT.]

RESTORATION of voluntary co-ordinated movements after "nerve crossing," first demonstrated by Flourens, has since been from time to time the subject of investigation. The conclusions of Flourens have been confirmed by Rawa, Stefani, Howell and Huber, Langley, and myself. A practical application in surgery was first suggested by Létievant, and within the past twelve years considerable development has taken place in this direction.

During the past two years I have performed about 30 experiments on monkeys and dogs in order to investigate several points from the physiological standpoint. These experiments fall naturally into three groups. The first deals with the methods of cross union or anastomosis between the peripheral segment of a divided facial nerve and a suitable motor nerve in the neighbourhood. The second series of experiments deals with anastomosis in the fore limb of dogs, in order to investigate some aspects of the question not overtaken by previous work on this part of the subject. The third series deals with the brachial plexus, its functions, and the methods of anastomosis applied to it.

The present communication is confined to an account of

experiments with the facial nerve, of which there have been 10 performed. Of these 10, 6 were primary anastomoses and 4 secondary anastomoses—that is to say, in 6 the facial was cut, and its peripheral segment immediately anastomosed with the central segment of the substitute nerve, while in 4 the facial was cut and left unattached for a period, precautions to prevent spontaneous reunion being taken, and then at the end of that period re-exposed and united to the substitute nerve.

Primary Anastomosis.

In the primary anastomoses two were in monkeys and four in dogs. Of the two monkeys, in one the facial was cut and attached to the side of the spinal accessory, and in the other it was attached to the side of the hypoglossal nerve. Voluntary dissociated movements of the face commenced to return in the former in 58 days, and in the latter in 32 days, and each of the animals had complete voluntary closure of the eye at about 100 days.

Of the four dogs, in two the spinal accessory was the substitute nerve, and in two the hypoglossal. Of the two spino-facial anastomoses one was an end-to-side and one an end-to-end, and the same variation was practised with the two hypoglossal-facial anastomoses.

The two spino-facial anastomoses commenced to recover voluntary dissociated movements of the face at 105 (end to side) and 90 (end to end) days respectively, and were almost complete as regards power to close the eye at 116 and 123 days respectively.

The two hypoglossal-facial anastomoses commenced to recover power to close the eye at 55 (end to side) and 84 (end to end) days respectively, and were very complete as regards closure of the eye at 142 and 107 days respectively.

Association movements of the face, on the normal distribution of the substitute nerve being innervated by the animal, were observed only in two of the experiments, one a spino-facial (end to side) in a monkey, and one a hypoglossal-facial (end to side) in a dog. In the latter case, every rapid movement of the tongue, as in eating, licking the lips, etc., was accompanied by a wink.

Secondary Anastomosis.

The secondary anastomosis experiments were performed in one monkey and three dogs. The monkey had spino-facial anastomosis (end to end) performed one month after section of the facial, and commenced to recover power to close the eye by means of the orbicularis at 46 days, and there was good reflex closure of the eye at 65 days.

In the three dogs the facial nerve was cut close to the stylo-mastoid foramen and precautions taken to prevent reunion, and anastomosis performed after the lapse of one month in two of the dogs, and after 100 days in the remaining dog. Of the two in which the interval of one month had elapsed, in one, a spino-facial (end to end) anastomosis, no recovery of voluntary function had taken place at 69 days, when the animal died. In the other in which a month's interval had elapsed, a hypoglossal-facial (end to end) anastomosis, voluntary dissociated closure of the eye commenced to return at 60 days and was complete at 93 days.

In the dog in which 100 days elapsed before substitution, an end to end spino-facial anastomosis was performed, and voluntary closure of the eye commenced to return at 124 and was complete by 167 days.

In every case except two a physiological examination was made, and proved that the recovery of movements which had taken place in the face was wholly due to impulses reaching the face via the substitute nerve. In both cases in which the examination was not made before death the animals died unexpectedly. In one of these no voluntary function had returned (dog), and in the other, in which restoration had taken place (monkey), the *post-mortem* examination showed that there had been no reunion with the central end of the facial, as the stylo-mastoid foramen was found completely obliterated by a bone plug which had been hammered into it at the operation.

As an addendum, reports of two cases of spino-facial anastomosis are given. The first is a report twelve years after the operation performed in a woman, and published in the *Philosophical Transactions* in 1901, in order to show the ultimate result. The second is a report of a case of facial paralysis of three years' standing in

* A paper read before the Royal Society on June 1st. The expense of this research has been defrayed by a Government grant from the Royal Society.