in what has been already said, co-ordination shows no deficiency.)

The condition of the electrical reactions was carefully studied by Dr. Alex. Bruce and myself; but we thought it well to get a special report from Dr. Milne Murray, the accomplished electrician to the Royal Infirmary, and his report is as follows:

Motor Points.		Galyanic.				Faradic.	
		KCC	ACC	AOC	KOC	Coil.	Ratio.
1	Flexor carpi radialis, right ...	0.5	1.4	9.0	—	135	} 4
2	" " " left ...	6.5	6.0	14.0	—	90	
3	Peronei " right ...	1.0	1.3	2.9	—	115	} 10
4	" " left ...	1.0	5.0	4.0	—	110	

Test No. 1 gives nearly normal reactions, except that KCC comes rather early, while ACC is considerably deferred. Faradic excitability is nearly normal.

Test No. 2 shows great lowering of the galvanic excitability, especially in KCC. This requires about twelve times as much as in the right side, while ACC requires $\frac{1}{4}$ times and AOC $\frac{1}{12}$ times as much as on the right side. The faradic excitability is also considerably reduced, the minimal contraction requiring $\frac{1}{2}$ times as much as on the right side.

Test No. 3 (lower limb) gives a normal reaction both to galvanic and faradic stimuli.

* Test No. 4 gives a normal KCC, while ACC and AOC approach each other, the latter slightly preceding the other. The faradic excitability is depressed as compared with the right side, in the ratio of 10 to 13.

The result of the examination shows great lowering of the galvanic and faradic excitability in the left upper limb and a smaller lowering in the left lower limb. The character of the response on the left side is not in any way abnormal. There is none of the "laziness" of contraction so often seen in certain stages of the reaction of degeneration.

Now if you refer to the table on the board you will see in the three columns into which it is divided, first, the normal relations of the faradic and galvanic current to healthy muscle and nerve; secondly, the conditions found by Dr. M. Murray in case of J. J.; thirdly, the conditions of reaction of degeneration.

	Normal.	J J. (Affected Side).	Reaction of Degeneration.
<i>Faradic :</i>	Reaction readily obtained	Excitability diminished especially in arm	Reaction greatly diminished.
<i>Galvanic :</i>	Reaction prompt and sharp	No laziness in contraction	Reaction lazy, sluggish, and prolonged.
		Arm.	Leg.
Appearance of contraction :	1. KCC	1 & 2. KCC and ACC (practically simultaneous)	1. KCC
	2. ACC		2. AOC
	3. AOC	3. AOC	3. KCC
	4. KOC	4. KOC	4. AOC

The condition thus bears no resemblance to the reaction of degeneration. With regard to vasomotor and trophic functions, the only point to be noted is that not only does the left leg measure less in circumference than the right, which might be explained by the old thrombosis, but the left arm also measures less than the right one, notwithstanding the fact that its muscles are generally in a state of violent contraction, and are so vigorous. The measurements taken in Glasgow compared with those we made here are as follows :

	Glasgow Infirmary.	Edinburgh Infirmary.
Right calf	14 $\frac{1}{2}$	15
Left calf.	14 $\frac{3}{4}$	14 $\frac{3}{4}$
Girth of wrist just above styloid process—right	6 $\frac{1}{2}$	7
—left	6 $\frac{1}{2}$	6 $\frac{1}{2}$
At deltoid insertion—right	9 $\frac{1}{2}$	11
“ “ —left	9 $\frac{1}{2}$	10 $\frac{1}{2}$

Comparing these measurements, we find that the girth has increased on both sides during the past two years and a-half; that the left or affected side is smaller than the right; and that the growth on the left side has been less than that of the right at all points measured excepting one—namely, the insertion of the deltoid.

These differences appear to imply a trophic change in the muscles of the left half of the body, and the appearance of a distinct degree of increased growth on both sides since he was examined in Glasgow. The shortening of the muscles, and the changes in joints and bones which the skiagraphs reveal appear to be secondary results of the long-standing spasm rather than of neurotrophic origin.

The cerebro-mental functions are at present natural, as are also both the spine and the cranium.

It is necessary to restate the facts of the case in brief form:

A soldier, aged 25, had severe typhoid in India ; on recovering from coma, found himself unable to use his left hand on account of stiffness of the fingers. Gradually they became flexed, and the arm, foot, leg, and left side of face became rigid with constant hypertonicity and frequent tonic spasms. This condition makes him resemble a case of hemiplegia with descending sclerosis, but there is no paralysis, and all the muscular disability is due to antagonistic action of opposing muscles. Otherwise at present no abnormality of any system or of the nervous system in any respect, except the unilateral spasm. The locomotory system is interfered with only in 'so far as the spasm, the contracture, and the consequent changes in joints and bones are concerned. He has, since his illness began, had two attacks of mania.

It should be particularly noticed, as to the state of the muscles, that the deep reflexes are exaggerated, and that, although the electric relations differ in the two sides of the body, there is no trace of the reaction of degeneration.

(To be continued).

ON THE ORGANISATION OF LABORATORIES IN HOSPITALS.

BY PROFESSOR DR. CARL VON NOORDEN,
Chief Medical Officer of the Municipal Hospital in Frankfort-on-the-Main.

If we cast a glance back over the scientific literature of medicine we shall see that a remarkable change has come about in the last decades. Only the literature which is concerned with clinical description has retained its ancient character; this will always be the case, since the varieties of the pathologic-clinical processes are inexhaustible. There will always present themselves to the attentive observer at the bedside novel phenomena which broaden our knowledge of diseases, and are full of importance in diagnosis.

If, however, we look beyond the records of symptoms, we are struck by the fact that the subjects to which our scientific investigations are directed have become altogether different. The journals and periodicals of the seventh and eighth decade of this century are filled with contributions on physical diagnosis, especially on the employment in diagnosis of auscultation and percussion. He who came to the study of his patients with acute senses and good powers of observation could at that time count upon making new discoveries and rendering important services to scientific diagnosis. Physical diagnosis in the narrower sense of the term was rendered complete down to its finest details upon the basis of the comparison of clinical phenomena with the results of *post-mortem* examination; what later years have added is very little. Beyond the pleximeter hammer and the stethoscope, the thermometer, the as yet imperfect microscope, and in rare cases the sphygmograph, were almost alone of service to the practitioner of medicine. A place of great importance was assigned to the thermometer. The investigations and discussions upon thermometry, on the course of febrile diseases, and on the therapeutic means of influencing the course of fever were scarcely less numerous and important than those on percussion and auscultation. At a later date and more slowly the microscope attained to a position of general importance in scientific work at the bed-

side. Clinical microscopy down to the end of the eighth decade made only a few noteworthy advances after its earlier important discoveries in the morphology of the urine, the blood, the sputum, and the faeces had been achieved. The microscope did more for the investigation of *post-mortem* material. It is very noteworthy and very instructive to observe that towards the end of the eighth decade, and also at a later date, numerous clinical observers in all countries devoted their scientific labour to the field of pathological and especially of microscopical anatomy. It was like an invasion into a foreign territory. When diseased organs were submitted to accurate microscopical examination, when anatomical changes were described down to the minutest details, and when experiments on animals were performed in addition, work was done which appertained rather to the anatomist than to the clinician. The consequence of this tendency was that for a young practitioner who desired to obtain a post as assistant in a clinical department there was no better recommendation than that he had occupied himself for some time in pathological anatomy—not only with naked-eye anatomy, which nevertheless is undoubtedly of great importance to every practitioner, but it was also desired, and, indeed, required that he should be able to make detailed investigations into the minutest microscopical anatomy.

We must, indeed, admit that during that period a great quantity of admirable and important work was produced by clinical professors, by assistants in clinical schools; and by other young practitioners who worked in the clinics, nevertheless we must note that this kind of work was along a wrong road, which led scientific clinical work away from its true function. It was a dangerous, false track, for it usurped the time and thought which the clinical observer should devote to the pathological processes of the living human being. The cause of this invasion of the territory of the anatomist by the clinical observers lie near at hand. Observation at the bedside had exhausted nearly all the methods at that time available; there was no more valuable fruit to be gathered either for diagnosis or for treatment through clinical work. Diagnosis and symptomatology thirsted after new ways of gaining knowledge; the therapeutics of the diseases which fall within the domain of medicine followed the old and oft-trodden road, and when contrasted with the gigantic achievements of modern antiseptic surgery gave rise to the same feeling of despair as in the days of Skoda. Thus the desire to work on scientific lines drove men into the foreign territory of pathological anatomy. It is a very noteworthy fact that in the many countries where the more recent auxiliaries of modern clinical work in hospitals are not available, the best investigations which issue from the clinical institutes still deal with pathological anatomy and histology; while in Germany, France, and Italy at the present day important work of this kind is undertaken by clinical teachers or their assistants only in very rare instances. Neurology alone affords an exception; the best investigations within its domain whether undertaken by clinical observers or by anatomists are concerned with microscopical pathology. This is due to the way in which neurology has during the last two decades grown to be a special study. I entertain the strongest doubts whether this direction which neurology has taken is the right one.

At the period to which we went back at the beginning of this article clinical chemistry was still in long clothes. Although some important discoveries were made in the field of the pathology of metabolism, yet the practitioners could be counted on the fingers who knew more about clinical chemistry than how to look for albumen and sugar in the urine. The poverty of the researches were in sharp contrast with the mighty strides which physiological chemistry and the study of metabolism had made in those days. It is true that some valuable observations on the pathology of the urine have come down to us from those days, but they were rather solitary unconnected observations than systematic studies. Still the new methods of studying metabolic changes quantitatively were employed at the bedside by some investigators, although few works of fundamental importance were published, these few works were all the production of German clinical teachers. What was done, however, showed that investigations in clinical chemistry promised to be extremely fruitful. Thus it is that we see that at the end of the eighth

and the beginning of the ninth decade a large number of young and ambitious medical men began to give serious attention to chemical studies and to look upon them as affording an important preparation for scientific work at the bedside, with what success is made plain by the many men who began their scientific career at that time whose names are now famous. Since that epoch the share of the clinical physician in chemical investigations has increased year by year. A large amount of original work of fundamental importance has been done by pathologists who have been equally accomplished as practitioners at the bedside and as experimenters in the laboratory.

The study of the chemical changes in the blood, and in the secretions and excretions, has grown ever more important and more rich in results, affording means for an understanding of the diseased processes which occur in the body. Every piece of knowledge gained afforded a suggestion for new researches. Most of these investigations into the pathological constitution of the blood in pathological states (proportion of water, quantity and nature of the proteids; hæmoglobin and its modifications, salts, acids, alkaloids, specific gravity, sugar, etc.), and into the chemistry of pathological urine (proportion of nitrogenous constituents, uric acid, alloxur bases, proportion of ammonia, rare nitrogenous bodies, and various forms of albuminous bodies and of carbohydrates, the proportion of salts, the excretion of aromatic substances, and of urinary pigment, etc.) could have been carried out by no one except hospital practitioners well equipped chemically. The chemist, without this close contact with clinical practice, and without an acquaintance with pathological occurrences, could never have advanced our knowledge so far. This is still more clear in regard to investigations relating to metabolism, the immense importance of which in deepening our knowledge of pathology is very apparent, and is more appreciated every day. The study of metabolism was, as it were, born in the physiological laboratory. It was there that the foundations on which we all stand to-day were laid by many experiments on animals and by some few on man. But these physiological inquiries were not sufficient for the needs of clinical medicine. We are indebted far more largely to assiduous work at the bedside during the last two decennia for the accumulated knowledge which has been gained of the pathology of metabolism, and for the foundations on which modern rational dietetic treatment rests. I will mention here only some of those important researches: The assimilation of proteids; oxidation and assimilation in fever; nutritional conditions in diabetes mellitus; the relation between proteid assimilation and fat destruction in obesity cures; the relative excretion of uric acid in health, in gout, and in other diseases under various kinds of diet; the secretion of hydrochloric acid in the stomach and its influence on digestion; the assimilation of food, especially of the various forms of proteid and fat in gastric and intestinal diseases; the assimilation of food after the complete or partial occlusion of the bile duct and pancreatic duct; the influence of a diet rich in proteids and of one poor in proteids on diseases of the kidney, especially in the degree of albuminuria; the influence of anæmia on the total proteid assimilation and on the oxidation processes, and on the absorption of nitrogen; the amount of food necessary for the sick in comparison with that required by the sound.

I have here referred only to a few selected examples of the important subjects with which the study of metabolism has been concerned during recent years. The reader who wishes to convince himself that these researches possess not merely a theoretical interest, but have exercised also a very great influence on the growth of modern therapeutics should consult the new *Handbook of Dietetic Therapeutics* which is now in course of publication by E. von Leyden with the co-operation of numerous investigators. On every page he will find proof of the dependence of therapeutics on the researches in metabolism carried out during the last two decades. No one who reads this book can fail to receive the impression that through the careful study of the pathology of metabolism, through the investigations of metabolic exchanges by various methods, medical treatment has been very greatly advanced, and has reached a position which is no longer inferior to that to which its brilliant achievements have raised surgical treatment. Contemporaneous with the development

of clinical chemistry was the triumphal appearance of clinical bacteriology. It is scarcely fifteen years since bacteriology attained to a position of importance in clinical medicine owing to Robert Koch's discovery of the tubercle bacillus. Within a few years bacteriology became of quite unanticipated importance in diagnosis. It brought about a complete change in our conception of very many pathological processes. It became a sure guide in the etiological differentiation of disease, whereas previously differentiation by symptoms alone had had a prominent place. In the gigantic work which was done, work which embraced every part of medicine, all countries and all hospitals took an assiduous part. We did not altogether escape mistakes; they were inevitable. But on the whole scientific medicine can look back with justifiable pride on the victories won by clinical bacteriology. From its first beginnings and throughout the whole course of its development down to the present day bacteriology has had the good fortune to be able to rely confidently on clinical medicine. The great results which have been attained have been reached through combined work done simultaneously at the bedside and in the laboratory. The bacteriologists were clinical physicians, and the clinical physicians were bacteriologists. Only in this way could such rapid development have taken place as has been effected in the etiological and therapeutic study of tuberculosis, of cholera, of rabies, of diphtheria, of septic diseases, etc. Whatever might be the direction in which the great pioneers of bacteriology succeeded in making a new discovery clinical institutions always at once co-operated in the work. Bacteriological diagnosis, etiological inquiry, the study of immunity, of immunisation, and of serumtherapeutics could never have attained so quickly to their present far-reaching importance had not all clinical institutes, large and small, been most readily provided with the means of taking part in the great work common to them all. In spite of the great results already achieved we are still, unless we are all mistaken, only at the beginning of an immense undertaking which is to be accomplished by theoretical research and practical medicine working together in close alliance.

The development which scientific medicine has undergone in recent years has imposed on hospitals duties which are entirely new. All the larger hospitals, and not those only which undertake to teach medical students and young practitioners, are under the obligation to co-operate in the further development of medical science. If to-day progress in scientific medicine is to be continued, medical men who are called to such work, that is to say, all hospital physicians, must have at their disposal the full equipment necessary for modern scientific investigation.

That it is the duty of the members of the medical staff of all hospitals to advance science and to incite the younger members of the profession to undertake scientific inquiries is self-evident, and does not call for further argument. To circumscribe the opportunities for work in medical teaching institutions, and to give instruction only in those ancillary methods which were found sufficient in past times, would be a crime against science which would be bitterly revenged in future generations.

But the justice of this claim seems to be equally self-evident in the case of these hospitals which are not teaching institutions, inasmuch as it is required of the medical staff of such hospitals that in every respect they should rise to the height of their science; and that in their practice, both in matters of diagnosis and of treatment, they should give the best which is possible in the existing state of the medical art. In order that they may do this and afford to their patients the service we have the right to required from them, they must have the opportunity of bringing to the bedside all the means of assistance provided by modern science. We do not demand from the medical officers of these hospitals independent original researches, but we do demand that they should be able to make the discoveries of others available in the fullest measure for their patients. We do demand of them a living contact with the progress of their profession. So soon as an advance has really been made in clinical chemistry, bacteriology, and microscopy, the fact must be taken into account, and every hospital should take care that the necessary auxiliary means are supplied. It is useless to

raise opposition to this. Those hospitals which fail to recognise the new needs and their medical officers likewise stand still, and where things are at a standstill there is always in scientific matters backsliding. Where the access to the sick-bed of our flourishing clinical medical science is hindered, there, in spite of all book learning, an understanding of the achievements of pathology, diagnosis, and therapeutics which we owe to the auxiliary sciences will also be wanting.

Medical men must recognise with thankfulness that the State and municipal authorities, and the governing bodies of smaller institutions, have already to a large extent taken cognisance of the modern progress of medicine, and have done much to provide a better equipment of scientific appliances for hospitals. If we who are medical men would count upon further advances, we must have a clear understanding as to the scope of the provision necessary to be made, and we must indicate what arrangements have proved themselves to be the best. I believe that I am in a position to express an opinion on this point because I have made myself acquainted with the organisation of most of the large municipal and State hospitals in Germany, and with no small number of those in Austria, England, and Italy.

In the first place I would utter a warning against making exaggerated demands. I have laid down the principle that as a rule hospitals should only be provided with means for undertaking such investigations as have a direct connection with clinical questions. All investigations which do not present this connection can be relegated without loss to other special scientific institutes.

The following organisation is sufficient:

I.—AN INSTITUTE FOR PATHOLOGICAL ANATOMY.

A special prosector should be appointed to the institute, whose duty it would be to make all *post-mortem* examinations for the various departments of the hospital, and to carry through microscopical and bacteriological investigations desired to the ward physicians. Material obtained from the living patient by operation (tumours, etc.) will be handed over to the prosector for examination and report. In large hospitals the prosector would be assigned one or two assistants, since he will not be in a position adequately to meet all the demands on him. The position of the prosector should be such that he is not made subordinate to the members of the medical staff in charge of wards, but is responsible as they are to the governing body of the institution. His salary must be sufficient to enable him to abstain from private practice. In Germany at municipal hospitals, which are not designed to be teaching institutions, such as the Moabit, Friedrichshain, and Urban Hospitals in Berlin, and the hospitals of Brunswick, Hamburg, and Chemnitz the prosector receives a salary of from 3,000 to 5,000 marks (£150 to £250). Further, the prosectors have the right to perform *post-mortem* examinations outside the hospital for medical practitioners in the town. By the fees which the prosector thus receives his receipts are increased by several thousand marks a year. On the other hand, the prosector is forbidden absolutely to engage in private practice. The whole arrangement has proved itself to work well, and several large towns in Germany intend to follow this example. Under the circumstances described it is easy, as experience proves, to find good men for these positions who possess the high scientific qualities necessary, and render to the hospitals much better services than when the necropsies were performed by the young hospital assistants.

There are advantages in this arrangement for the medical practitioners of the town, since they have always a specialist in pathological anatomy with whom they can consult, and since the opportunity is afforded to them of gathering further knowledge from the courses of demonstrations which the prosector may hold.

In the pathological institute of the hospital there should be room enough to allow the medical staff of the hospital, especially the younger members, to have the opportunity of engaging in histological investigations and to examine anatomico-pathological material in which they may be interested under the responsible guidance of the prosector. Where possible there should be room enough to afford working places for a few practitioners of the town who may be interested in microscopical investigations.

II.—THE BACTERIOLOGICAL LABORATORY.

The bacteriological laboratory should be in structural and organic connection with the anatomical institute. It likewise should be under the direction of the prosector, who in large hospitals should have the aid of special assistants. It would be the duty of the prosector and his bacteriological assistants to carry out all the bacteriological inquiries desired by the staff of the medical, surgical, and gynaecological departments, and thus to give important aid in etiological diagnosis and in therapeutics. The laboratory must contain adequate provision for carrying out the various methods of cultivation employed in bacteriology and for conducting the more important experiments on animals necessary for bacteriological diagnosis. Two or three rooms and a few hutches for small animals suffice. It is not in my opinion necessary in ordinary hospitals to go beyond this, and to make arrangements for serum experiments, for studies in immunity, and for extensive investigations in disinfection. The methods necessary for such inquiries are now so complicated that they presuppose a special establishment. It is therefore better to establish for difficult investigation of this kind special centres, as has been done in Berlin in the Institute for Infectious Disease, and as is about to be done at the municipal hospital in Frankfort-on-Main. Under an agreement made between the State and the municipality the German Reichs-Institut für Serumforschung und Serumtherapie will be connected with this hospital.

In many towns the plan has been tried of permitting the director of the anatomico-bacteriological institute to undertake bacteriological investigations for medical men practising in the town. In practice advantage is taken of this arrangement mainly for the identification of the bacillus of tubercle and the bacillus of diphtheria, and occasionally for the serum diagnosis of typhoid fever.

No rule of general application can be laid down as to the limit of the work which should fall to the prosector. It would be very wrong to throw upon him every task which comes within the range of histology and bacteriology. Now, as formerly, a large part of this kind of work should be done by the ward physician. To this category belong the ordinary microscopical examination of sputum (including examination for tubercle bacilli), the microscopical examination of urine, fæces, blood, etc. These matters have so direct a connection with clinical medicine that they should always be undertaken by the physician who is treating the case. In my experience it is much better that these investigations especially should not be carried on in the rooms of the anatomico-bacteriological institute. Several small rooms in the immediate neighbourhood of each ward should be provided for this purpose. This is a much better arrangement than that every urine glass and sputum vessel should have to be taken to a distant building for the examination of its contents. The facilities provided by the institute should, however, at once be made use of when difficult and lengthy investigations have to be made, as, for example, the identification and cultivation of micro-organisms in the sputum, urine, fæces, nasal, vaginal, and urethral secretions, blood, pus, skin, etc.

III.—CLINICAL CHEMISTRY.

Clinical chemistry stands in a different position with regard to the anatomico-bacteriological institute. Extended chemical investigations for which much apparatus is necessary have hitherto been limited to the domain of medicine proper. My own opinion is that this is a mistake, and that in the domains of surgery, obstetrics, and dermatology many treasures are to be unearthed by chemical inquiries. But for the moment we must look at the facts as they are, and we must regard it as useless to provide extensive chemical laboratories for these divisions of medicine before those who follow them have begun to display a greater interest and a greater knowledge of the metabolism of the organism. Whereas the anatomico-bacteriological institute ought to be associated in an equal degree with all special departments of the hospital, this is not the case with the chemical laboratory. In consequence it is best to place it under the direction of the chief physicians of the medical wards. This arrangement has already been adopted in Germany in all the university clinics, and in most of the large municipal hospitals, and has worked very well. A very large number of valuable articles on the chemistry of

the fluids of the tissues, on secretion, and on excretion, and important contributions on the pathology of metabolism and the therapeutic methods of influencing the metabolic exchanges have during the last two decennia issued from such chemical laboratories established in connection with the medical departments.

The question may be raised whether it might not be advantageous to give to the chemical laboratory, as to the anatomical institute, a special director who, like the physicians of the hospital, would occupy an independent position. I consider that this is only necessary in the largest hospitals where several independent medical departments exist together. The appointment as director of a chemist or of a physician who has made a speciality of physiological chemistry lays us open to the danger that the work undertaken in the laboratory may lose its connection with clinical medicine, and assume a purely chemical character. For such work, however, no clinical laboratory is needed, since the university laboratories for chemistry and physiological chemistry exist for this purpose. The clinical laboratory should only supply the means of bringing to bear the achievements of practical chemistry and the discoveries of physiological chemistry at the bedside for diagnostic purposes and for the advancement of the pathology of metabolism. This, of course, does not forbid that work done in the clinical laboratory may on occasion concern itself with questions of pure analytical and synthetical chemistry, but whenever the appliances of the laboratory do not suffice for these special studies the investigator must continue his work in another institution dedicated to pure chemistry.

The organisation necessary for a laboratory for clinical purposes is neither very extensive nor very costly. Two work-rooms corresponding in size to the number of the physicians working in the laboratory will suffice. In addition, there should be a room for weighing and for delicate physical instruments (polarisers, spectroscopes, etc.). Finally, there should be a scullery. If investigations requiring gas analyses are to be undertaken (estimation of oxygen exchange, of CO₂ production, of blood gases, etc.), an additional room will be necessary. I may state, as affording some estimate of the cost, that the complete and very extensive installation of the chemical laboratory of the municipal hospital at Frankfort-on-Main cost 7,000 marks. In this sum is included the exceptionally serious expense of a Geppert-Zuntz respiration apparatus.

As in the case of the anatomico-bacteriological institute the chemical laboratory should be relieved from undertaking the continually-recurring smaller investigations in clinical chemistry. It would be out of place, and a great hindrance to the work were every urine which had to be examined for albumen, sugar, urobilin, indican, bile pigments, etc., at once taken to the laboratory. These every-day qualitative examinations should rather be made in the ward or in an adjoining room. The material should be taken to the laboratory only when quantitative investigations are necessary: or when special exactitude or extensive preparations are required to obtain the qualitative reactions.

Obviously, in hospitals where unlimited funds are available we may go very much beyond the skeleton organisation here described, and provide in connection with it large and magnificent institutes for histology, bacteriology, and chemistry. But these will be rare exceptions, and will only find their justification when the hospitals are concerned with the noble and important task of medical education. What is necessary in this case I need not here describe, because there is no difference of opinion upon the matter. The object of this short article is rather to state the extent to which every large general hospital must find a place for the modern sciences every day growing in importance, which are ancillary to clinical medicine. I have intentionally not made its scope wider than is absolutely necessary. If, avoiding exaggerated demands, account be taken of what is really necessary within the limits I have here set, the scientific education of many practitioners of medicine will be advanced, their living contact with all advances of science will be facilitated, the whole science of medicine will be advantaged, and the sick will be benefited. It must not be contended that by establishing such laboratories hospital physicians will be turned away from the essential business of hospitals, which is the treat-

ment of the sick. Experience proves that this is not the case; the new organisations, especially when they are closely united to the hospital, afford them rather the opportunity of bringing to the service of their patients new means of cure.

ON THE CAUSE OF SO-CALLED PHOSPHORUS NECROSIS OF THE JAW IN MATCH-WORKERS.

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HISTORICAL SUMMARY.

PHOSPHORUS was first used in the manufacture of matches in 1833 at Vienna. Shortly after its introduction, and ever since, cases of necrosis of the bones of the upper and lower jaws have occurred among the workpeople employed in match factories. The condition was first described by Lorimer, who, between the years 1839 and 1845, saw 9 cases in Vienna, but immediately after cases were also reported in Nürnberg, Strassburg, Berlin, Lyons, Paris, Manchester, and London as having occurred among the workers in match factories. Improvements in ventilation and in manufacturing machinery have greatly diminished its frequency, but it has continued to be not uncommon, and is widely recognised as a risk incurred by those who work with phosphorus. The clinical symptoms have been fully described by Lorimer, Heyfelder, von Bibra, and Geist, Harrison, Roussel, and others. In addition to their more systematic descriptions many isolated cases have been put on record by different writers, and all agree substantially in their main features.

SYMPTOMS AND COURSE.

The disease may begin after a few weeks or months, or many years' employment in the factory, generally with tooth-ache, and always in a carious tooth or in the socket of one which has been extracted. Its further progress may be very slow, the pain and inflammation remaining slight, and confined to the immediate area of the one tooth. Sometimes, however, it runs a much more acute course, and may involve a large part of the jaw in a few weeks or months. In either case, when the process once begins to extend, the gum becomes red, tense, and swollen, and the swelling may then resolve itself into a circumscribed phlegmon, or may form a large tumour which spreads to the neighbouring soft parts, causing a swollen appearance of the lips and cheeks, or the regions under the lower jaw. The abscess then bursts or is opened, when it discharges stinking pus, and in its place an ulcer quickly forms, which lays bare the bone. The discharge is greenish, greyish, or sanious, and contains a quantity of bony detritus. The teeth become loose and fall out at the diseased part; the gum becomes livid, and fistulous openings form in it from which pus discharges continuously into the mouth, or the pus may burrow and discharge externally through the skin of the face by several small openings. On probing these openings, bare bone can be felt. Later the gum disappears, and exposes the alveolar arch and other parts of the jaw, the bare bone having a brownish or dirty-grey colour; its surface is roughened and eroded, evidently in a condition of caries, and the pus can be seen oozing from its surface. The salivary and neighbouring lymph glands are hard and swollen. Larger or smaller portions of the jaw-bone then become necrosed, in process of time get loosened and detached from the rest, and ultimately exfoliate or can be easily removed with forceps. There is great difficulty in chewing and swallowing, and the patient has to live on soft food and liquids. The process may last for months or years, and may be entirely confined to the upper or lower jaw, the general health remaining fairly good. It may spread from one part of the jaw to another, or from one jaw to the other.

In the most favourable cases, after portions of the jaw have necrosed and been removed, the whole process may cease, new bone is formed from the periosteum, and cicatrization of the soft parts takes place. But there is always more or less deformity, sometimes very slight, sometimes very severe, and the alveolar arch is never restored.

In other cases the disease, instead of healing, spreads

locally, involving more bone, the patient becomes cachectic, feverish, and wasted, and ultimately dies of pulmonary phthisis, general tuberculosis, or some other tuberculous affection. A few cases run a very acute course, both as regards the local and general conditions, there being very great destruction of bone and very severe systemic disturbance, death occurring in two or three months.

PATHOLOGY.

As regards the bone, the condition is one of cario-necrosis, there is chronic otitis and periostitis, and it differs in no respect from the same lesion as seen in other bones and from various causes.

It has long been held that this necrosis, or cario-necrosis as it should rather be termed, is due to a specific action of phosphorus fumes on the bone, these being supposed to cause a peculiar and specific kind of inflammation. If one considers, however, the whole circumstances and the clinical histories of individual cases, the conclusion must inevitably be drawn that the process is due to infection from a micro-organism. Phosphorus fumes consist of phosphorous anhydride (P_2O_3) chiefly, with some phosphoric anhydride (P_2O_5), and during the oxidation either ozone or hydrogen peroxide is also formed in small amount. From what we know of suppurative processes, it is inconceivable that any of these bodies can cause a chronic purulent inflammation of bone such as has just been described as occurring in "phossy jaw."

Acting on this idea I applied to Mr. Cornelius E. Garman, surgeon to Messrs. Bryant and May's match factory, who very kindly has supplied me with specimens of pus from six cases of phosphorus necrosis of the jaw under his care at the present time. In every case the pus was very foetid and was greenish, or brownish, or greyish in colour. Attempts to make cultivations from the pus revealed the presence of staphylococcus albus, streptococci, and numerous other organisms, none of which could reasonably be regarded as the cause of the cario-necrosis.

PRESENCE OF TUBERCLE BACILLI.

It is well known that tubercle bacilli cannot be cultivated from pus, but on staining cover-glass preparations of the pus by the Ziehl-Neelsen method the bacillus tuberculosis was found in every case. As is usual in the discharge from tuberculous bone, the organisms were few in number and difficult to find except on the closest and most careful examination. On centrifuging the pus and then examining the sediment they were more easily detected. Sometimes several cover-glasses had to be examined before any of the organisms were seen. Most of the bacilli were perfectly typical in appearance, others were small and thick, resembling the forms usually found in the urine. They were scattered about singly, or in small clumps, or in groups of one or several dozens.

Inoculation of guinea-pigs with the pus did not infect these animals with tubercle, and hence the bacilli must be regarded as being either dead or as having almost entirely lost their infective virulence. It is now proved, however, that tubercle bacilli in this condition are quite capable of setting up and maintaining local suppuration and irritation for an indefinite time. Besides, they are assisted by the action of the pyrogenic organisms with which the pus swarmed. The condition of the tubercle bacilli is probably to be explained by the fact that all the cases which I have had an opportunity of examining are recovering, and have been under treatment for very long periods with antiseptic mouth washes, etc. The condition generally is exactly similar to what is seen in tuberculosis of the jaw in cattle and in tuberculous disease of other bones in man. The presence of the tubercle bacillus can hardly be regarded as fortuitous, seeing that it was found in every case, and its presence is held, so far as our present knowledge goes at least, to be proof positive of the tuberculous origin of any lesion.

If further proof of the tuberculous nature of the jaw disease were wanted, it is to be found in looking through the accounts of *post-mortem* examinations of fatal cases. In most cases death occurs from tuberculosis of the lungs. Whether this is due to infection from the jaw tubercle, or whether the phosphorus fumes damage the lungs, and make them more susceptible to direct infection, I am unable to say.