

MEDICO-SURGICAL SUGGESTIONS

Vol. VI.

APRIL 1932

No. 4.

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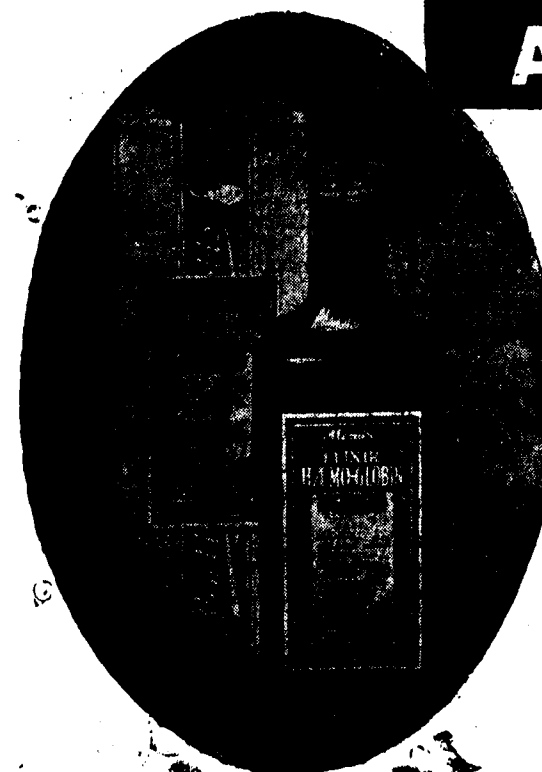
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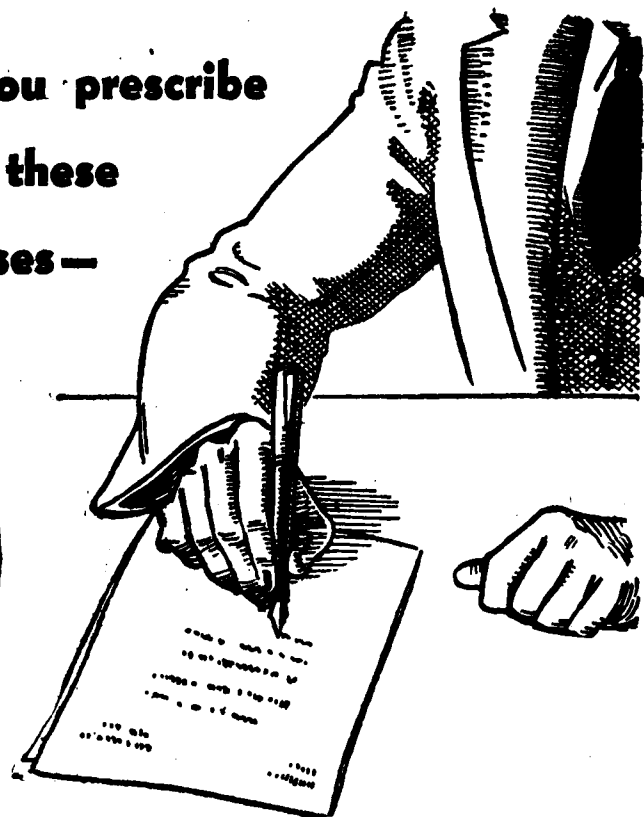
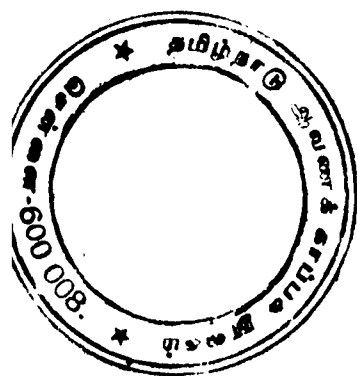
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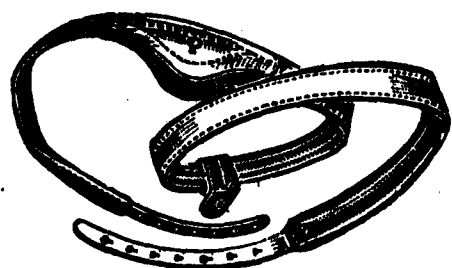
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Original Article

THE BACTERIOPHAGE.

BY DR. V. N. KRISHNA MURTHY, M.D.

Hook-worm Unit, Periyapatna.

Bacteriophage or simply 'Phage' is a term applied to a group of substances having the ability to dissolve (lyse) a growing bacterial culture 'ad infinitum.'

In 1917, d'Herelle isolated a substance, in sterile filtrates from stools of a patient suffering from Shiga dysentery, which inhibited the development of Shiga dysentery organisms in broth culture. Subsequently he found that when such a filtrate was inoculated into a young broth culture of dysentery bacillus (Shiga) and further incubated, a gradual clearing of the culture occurred after 10—12 hours, indicating dissolution of the bacteria. d'Herelle devised another method to demonstrate the character of bacteriophage, which is adopted by many workers for the detailed study of the phenomenon. He found that when a very small quantity of a lytic filtrate was added to a young growing bacterial culture of Shiga and subcultures were made upon agar from the mixture, the surface growth on agar showed sharply punched out clear areas devoid of any organismal growth. d'Herelle claimed these areas to be the colonies of bacteriophage.

THE GENERAL CHARACTERS OF THE BACTERIOPHAGE.

The power with which a given phage lyses the bacteria varies very greatly. The phage activity was first observed on the colityphoid-dysentery group of organisms and was thought to be limited to this group only. Later work points out that this phenomenon extends to other organisms like staphylococcus, streptococcus, etc.. The lytic principle becomes increased in the course of its action as could be proved by d'Herelle's agar-plate method. If tubes of Shiga bacilli be inoculated with a minimum quantity of the lytic principle and plating carried out at different periods of incubation, the number of clear colonies on agar plates become progressively more numerous until the final plate shows no evidence of bacterial growth. For the

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production of this phenomenon, living cultures are necessary. No action can be demonstrated on dead bacilli. The phage is ubiquitous in its distribution, but always in association with living bacteria. It has been isolated not only from faeces of normal and diseased persons and animals but also from water, sewage, soil, etc. It is also present, active or latent, in many laboratory cultures. It passes through the whole series of Pasteur-Chamberland filters. Phage action is found not only to be group specific but also type specific, e.g. the phage against typhoid acts against that only. It is also well known that phage possesses antigenic properties. The action of phage on bacteria is very interesting. Soon after phage comes in contact with the bacterium, it is absorbed by the latter as shown by Lepper. Later the bacteria are seen to swell up, become spherical and disappear in the form of fine granules, after suddenly bursting up. According to Bronfenbrenner, the destruction is preceded by a temporary acceleration of the bacterial growth. When the phage activity is very marked, the bacterial suspension may be completely destroyed but more often some of the organisms survive and on further incubation a growth appears after a few days. These are what are known as the phage resistant strains or the 'secondary cultures' of d'Herelle. Such resistant strains are known to exhibit properties very different from that of the parent strain.

It is almost twenty years since phage was discovered and certain properties like filterability, particulate nature, specificity and antigenicity are well known. Despite the enormous literature available on the subject, the main question 'What is Phage?' yet remains unanswered.

The nature of phage is a long disputed point and many theories have been put forward, chief of them being.

(1) d'Herelle's theory that phage is a living organism and that it is an obligatory parasite of bacteria.

(2) A second theory that phage is not a living organism but the action of phage is due to some autolytic ferment.

(3) Bordet's view shared by many, is that a mutation induced in the bacteria causes autolysis, setting free the active lytic substance. He is of opinion that a 'hereditary' nutritional vitiation of the bacteria takes place setting free the lytic substance.

The inability to find out the exact nature of phage by the earlier methods left many a worker in despair and physical and biochemical methods are being sought to tackle the problem. Valuable information is available from the interesting reports of various workers in the field. I shall endeavour to summarise some results which have practical bearing on the subject.

1. *The Particulate nature of phage.*

d'Herelle concluded that phage exists in the form of corpuscles by citing the experimental fact of the formation of colonies on agar

plate. The experiments of Feemster and Wells are in close agreement with the law of chance distribution of particles in suspension, substantiating d'Herelle's view. Bechhold, Prausnitz and others have fixed the diameter of phage to be about $20 \mu\mu$. Elford and Andrews, using a well controlled ultra-filtration technique, concluded that the phage particles vary from $10-75 \mu\mu$. Burnet's microphotographic technique, Schlesinger's rapid centrifugation experiment and his ultra-microscopic technique all point out that phage is a colloidal suspension and that the various phages differ in size, varying from $10-75 \mu\mu$.

On the other hand, the findings of Krueger and Tamada that a purified protein-free phage would pass through an ultra-filter while crude phage is ordinarily retained, the findings of Hetler and Bronfenbrenner from the diffusion co-efficient method that the phage preparation contains particles of varying size and that the active principle gets absorbed on these particles, and the findings of Krueger and Tamada that phage shows increased susceptibility in purified preparations to chemicals, heat and changes in pH, all indicate that the lytic principle is adsorbed by an inert carrier, the latter acting as a protective colloid. It may be that the carrier is a fragment derived from the bacterial disintegration. Analogous to this is the well known fact of protection of an enzyme by its substrate against heat and cold. The view that phage is a particulate body has to be further substantiated before it could be accepted.

2. *The effect of physical and chemical agents on phage.*

There is no doubt that most phages are inactivated by exposures to higher temperatures ($75-80^\circ\text{C}$ for 30-60 minutes), though some have recorded heat resistant strains. Burnet and McKie point out that heat inactivation is quickened by the presence of small quantities of Sodium, Potassium and Ammonium salts but inhibited by the presence of Calcium, Magnesium and Barium salts. d'Herelle reports that phage resists exposures to low temperatures like that of liquid air for ten minutes. Phage preparations retain their activity for more than ten years. Dessication seems to have little effect on phage. Ultra violet radiation is detrimental to phage while exposure to X-rays and radium emanation produce no demonstrable effect.

According to d'Herelle phage survives even three days' exposure to 0.5 per cent Perchloride of Mercury. Inactivation of phage takes place in 1 per cent phenol only after a week. Phage withstands the action of 20 per cent Hydrocyanic Acid and thus behaves like an enzyme. Formaldehyde, even in small concentrations (0.6 per cent), destroys phage activity completely within 5 minutes (Prausnitz and Fille). Bronfenbrenner and Korb found the purified phages to be more resistant to the action of chemicals than the crude ones. Burnet and McKie state that methylene blue, toluidin blue and janus green inactivate dilute phages very readily. Wells and Sherwood

report that crystal violet selectively inactivates only the phages of Gram-positive bacteria. They also found the phages for Gram-negative bacteria to be more resistant than those for Gram-positive bacteria.

3. *The effect of bacterial extracts on phage.*

Levine and Frisch report the specific inhibition of phage by bacterial extracts. They found that the homologous strains specifically inhibited their own phages. They point out that this phenomenon could be applied for the classification of bacteria in terms of phage action. The principle is successfully adopted by some, to classify the various strains of dysentery group of organisms.

4. *The phage-bacterium reaction.*

Certain facts are well established about the phage-bacterium reaction.

- (a) The phage action is active only on a living culture.
- (b) When phage and living bacteria come in contact with each other, the phage gets adsorbed by the bacterial cell.
- (c) As bacterial growth commences the formation of phage also commences. Active cell division seems to be an essential factor for phage action.
- (d) The rate of production of phage is many times more than the rate of bacterial reproduction.

(A) *The effect of phage on bacteria.*

The effect of phage on bacteria has been correctly described by d'Herelle. Observing the effect under the microscope, he found that the bacteria become elongated, spherical and swollen. At a later stage refractile granules appear leaving no trace of the bacterial cell. He also found that the lytic agent is regenerated during the course of its action on bacteria and that the turbid bacterial suspension after a time becomes clear. He thought that the phenomenon consists in the fixation of phage to the bacterium, followed by its penetration into the bacterial cell where multiplication of phage takes place. The view, that such a multiplication of phage takes place in the bacterial cell, is not well substantiated and is held to be incorrect. The work of Krueger points out that the adsorption of phage by the living cell is an unstable and reversible one while that by the dead is stable and irreversible. Bronfenbrenner and Hetler report that there is a temporary stimulation of bacterial growth before lysis commences in a phage-bacterium mixture. Krishna Murthy tracing the growth curves of *B. Coli* both in plain broth and in phage-containing broth, observed no such stimulation of bacterial growth. Krueger, Northop, Elford and others also failed to find any such growth stimulation.

(B) *The development of phage resistant strains in phage-bacterium mixtures.*

The destruction of bacteria in phage-bacterium mixture is not complete in many instances. More often some of the organisms

survive the action of phage and if incubation is continued further, a growth occurs in the phage-treated broth. Such growths are the so named 'phage-resistant strains' or the 'secondary cultures' of d'Herelle. The phage-resistant growths exhibit properties, very different from that of the parent strain. Variation in colony formation is of frequent occurrence and the so called 'flatten formen' described by Gildemeister are often exhibited by the resistant strains of *B. Coli*. Burnet, working on the smooth-rough variation with reference to phage, found that the 'S' type produced 'R' variants and *vice versa*. Morphological changes like *cocco-bacillus* and *cocci* forms from a typical *bacillus* are often observed. In some cases non-capsulated organisms are known to acquire capsules. Increased virulence, development of hæmolytic types from non-hæmolytic strains, changes in Gram-staining power, altered cell metabolism and variations in bio-chemical and serological reactions are some of the properties exhibited by the phage resistant strains.

5. *The adaptation of phage.*

d'Herelle and others report the easy adaptation of phage to the action of heat, chemicals and changes in pH, thus stressing the living theory of phage. According to him, phage gets easily adapted to various concentrations of glycerol. Prausnitz and Firlie report successful adaptation of phage to phenol and chinolol. Prausnitz finds that phage gets adapted to anti-phage serum also.

Equally convincing are the experiments by Beard and others to demonstrate the non-adaptability of phage to heat, chemicals, anti-phage serum and changes in pH. It is the opinion of the writer that phage adaptability is to be substantiated by further work as the available experimental data of phage-adaptation are well within the limits of experimental error.

6. *The electrical charge of phage.*

Todd, experimenting on the electrophoresis of Shiga phage, found that the phage particles migrated towards the anode over a range of pH 3.6 to pH 7.4. Using a modified apparatus, Natarajan and Hyde observed that a large number of phages migrated towards the anode under a wide pH range while a few showed amphoteric behaviour in slightly alkaline solution. Thus, the available data points out that most phages bear a negative electrical charge over a wide range of pH. Occasional amphoteric behaviour of phages in alkaline solutions are also mentioned.

7. *The purification of phage*

Crude phage is invariably contaminated with bacteria, the products of bacterial metabolism and disintegration and other foreign proteins. Various methods have been employed for the purification of phage. Krueger and Tamada employed electrophoretic migration of phage particles into agar-gel from which they recovered phage in a pure state. Many employ the adsorption-elution process to prepare

pure phage. Clifton used aluminium hydroxide as the adsorbent and secondary ammonium phosphate solution for elution. Some use kaolin for adsorption and ammonium hydroxide for elution. Karl Meyer has employed a new method for the purification of phage. Alkalised phage is treated with colloidal iron and the precipitate is discarded. The supernatant fluid is acidified and sodium flavinate and solid barium chloride are added. pH is brought to 7.6; the formed precipitate is discarded and pH further adjusted to 8.4. The barium is removed. The final precipitate which contains phage is washed and suspended in acidified water. The barium is removed by treatment with sodium sulphate. Phage remains in the solution. Such a preparation is found to be active even in dilutions of 10^{12} . Schlesinger prepared phage in synthetic media and subjected it to high speed centrifugation, when a jelly-like sediment was obtained with all the properties of phage. Such a sediment is found to be Gram-positive and gives positive Biuret and Millon reactions. Carbon, Hydrogen, Nitrogen and Phosphorous are obtained on analysis of the sediment. He concludes that phage particle is chiefly a protein, of the nature possibly of a Nucleo-protein.

8. *The antigenicity of phage.*

Bordet and Ciuca demonstrated that repeated injections of phage to an animal cause the appearance of anti-phage bodies in the animal's serum. This antigenic property of phage has been confirmed by other workers. The antigenicity like that of bacterial antigenicity is specific. It is known to evoke agglutinins and other neutralising substances. Bordet thought that the neutralisation of phage is effected by the destruction of phage by the anti-phage serum. This contention is proved to be incorrect as phage can be easily recovered from a phage-antiphage mixture without any loss of potency of phage. Several workers believe that the mechanism is analogous to toxin-antitoxin neutralisation. Complement does not seem to play any role in the reaction.

9. *The specificity of phage.*

d'Herelle's belief is that phage is a single substance with the ability to adapt and lyse many bacterial species. The fact that there is a strict specificity of phage to bacteria, the proof that different phages react differently to effects of heat, chemicals, etc., the different plaque characteristics, the different particle sizes and inhibition only by the extract of the specific bacterium, all point out that there are many types of phages.

Discussion.

Despite the enormous amount of literature available on the subject, we are yet at a loss to know what phage is. As it stands now, there are two schools of thought: while one favours the living nature of phage the other swears that phage is a non-living entity of the nature of an enzyme. The particulate nature of phage with

different diameters for different phages, the specificity of phage to the particular bacterium, the multiplicity of phage and the fact that each phage gets specifically inhibited by the extract of the corresponding organism, all favour the living theory of phage.

Equally convincing are the proofs to show the non-living nature of phage. The lack of sufficient evidence to prove that phage possesses the power of assimilation, that it has an independent metabolism of its own and that it is adaptable, makes one doubt the living nature of phage. Further, phage withstands exposure to higher concentrations of hydrocyanic acid, behaving like an enzyme. The fact that a phage inactivated by perchloride of mercury could be restored to activity after the precipitation of the Hg ions, is analogous to the behaviour of an enzyme (Krueger and Baldwin). Stanley's discovery, of an active crystalline protein possessing all the properties of the tobacco mosaic virus, is sufficient proof that a disease could be caused by an auto-catalytic protein requiring the presence of a susceptible living cell for its propagation and there is no reason why phage should not be of such a nature. But the fact that phage and enzyme share many properties in common, does not conclude that phage is an enzyme.

Though the problem of phage yet remains unsolved, the available data supports the writer to favour a modification of Bordet's theory; namely—'a mutational change is produced in the bacteria which brings on autolysis in them liberating an active lytic substance. The lytic substance, in its turn, induces mutation and autolysis in other bacteria and thus a continuous mutation-autolysis-phage cycle is set up.'

—(Mysore Medical Association Bulletin No. 15).

Selected Articles **THE PAINFUL SHOULDER.** GEORGE A. UNFUG, M.D.,

Pueblo.

The painful shoulder probably causes as many diagnostic and therapeutic difficulties as any other articulation in the body with the possible exception of the lumbo-sacral and sacro-iliac regions. Treatment generally has been a bit and mis proposition with apparently no definite scientific basis, chiefly because there was not a clear understanding of the pathology present.

The following are some of the causes of shoulder pain mentioned in a small collection from the literature: Fracture, dislocation, muscular strain, thermal change, arthritis, synovitis, fibrositis, myositis, sub-acromial bursitis, muscular paralysis, angina pectoris, aortic atheroma, aortic aneurysm, pleurisy pneumonia, tuberculosis, intra-thoracic new growths, pneumothorax, flatulence, indigestion,

gastritis, gastric ulcer, gastric cancer, duodenal ulcer, gallstones, cholecystitis, nutmeg liver, new growth of the liver, hepatic abscess, hemiplegia, herpes zoster, caries of cervico-dorsal spine, new growths of cervicodorsal spine, syphilitic cervico-dorsal pachymeningitis, cervico-brachial neuralgia, brachial neuritis, multiple peripheral neuritis, cervical rib, tumor in posterior triangle of neck, enlarged glands in axilla, aneurysm of subclavian artery, spinal cord tumor or spinal gliosis, neuromata, adiposa dolorosa, pulmonary infarct, lesions of lower right lung, perforated gastric or duodenal ulcer, subphrenic abscess, perforation of the gallbladder, perisplenitis, spontaneous rupture of the spleen, acute pancreatitis, appendicitis, pressure of drainage tubes, suprarenal tumor, tumor of the hypophysis, hiccup, apical tuberculosis, new growths of upper lung fields, ruptured ectopic pregnancy, pneumoperitoneum, intra-uterine, insufflation for determining patency of tubes, calcified cervical glands, spurs on clavicle, and osteomyelitis.

The purpose, however, of this paper is to describe the role of x-ray examination in this difficult condition. I shall present briefly the x-ray findings in some common lesions in the immediate vicinity of the shoulder, namely: 1. Cervical rib. 2. Arthritis of the shoulder. 3. Arthritis of the cervical spine. 4. Calcified cervical glands. 5. Acromio-clavicular separation. 6. Arthritis of the acromio-clavicular articulation.

I shall describe more in detail the x-ray findings in supraspinatus tendon injury, giving the pathologic background for each, and show why our present knowledge supports the opinion that the primary pathology in so-called subacromial and subdeltoid bursitis is in the tendons of the short rotators of the shoulder, usually the tendon of the supraspinatus muscle. I shall also stress the importance of proper radiographic technic in examinations of the shoulder region.

Cervical rib is a not infrequent cause of pain in the shoulder, the pain being due to a mechanical irritation of the brachial plexus. These ribs may vary in size from an elongated transverse process of one of the lower cervical vertebrae to a separate rib several inches in length. It must be remembered that only 5 per cent of cervical ribs give a brachial plexus effect.

Arthritis of the shoulder is not so common as arthritis elsewhere in the body. There are several types of shoulder arthritis: those due to specific disease such as tuberculosis; those due to remote foci of infection; and, more recently described, a type believed to be due to hyperparathyroidism. The x-ray findings are the same as in other joints except that they are much less marked in relation to the subjective symptoms. These findings are:

1. Bone production. }
2. Bone destruction. }

(with one or the other predominating)

3. Narrowing of the joint space.

4. Haziness over the joint space (in some types, especially tuberculosis).

The shoulder pain from an arthritis of the cervical spine is difficult to explain since we may have marked x-ray findings and few symptoms or few x-ray findings and severe symptoms. Considerable research at this time is endeavouring to explain this apparent paradox. Some, at least, of the shoulder pain in these cases is due to involvement of the brachial plexus. The bony exostoses, with or without narrowing of the joint space, and bone destruction visualized on the roentgenogram are too well-known to require detailed description.

According to Butler and Elward, calcified cervical glands may cause shoulder pain, but the only cases I have seen were picked up accidentally in routine x-ray examinations of the shoulder or cervical spine. Here, again, the cause of the pain is believed to be due to a mechanical or inflammatory irritation of the brachial plexus.

Acromio-clavicular separation is a not uncommon occurrence, but it is interesting because of the fact that in milder cases it is sometimes very difficult to make a diagnosis, both from the clinical and x-ray standpoints. Clinically, one is often misled by a false crepitus or grating sensation which may be encountered in almost any normal acromio-clavicular articulation. Radiographically, one can be misled if only the usual view of the shoulder is taken. Frequently it is necessary to make roentgenograms with the arm in two positions, abduction and adduction, and it has been found that plates made with the patient standing will frequently reveal a separation when all other methods fail.

Arthritis of the acromio-clavicular articulation is evidenced on the roentgenogram by mixed hypertrophic and atrophic changes and by a narrowing of the joint space. Its chief importance, from the x-ray point of view, lies in the fact that a true arthritis of the joint must be differentiated from simple hypertrophic excrescences of the acromion which are occasionally secondary to an old injury of the supraspinatus tendon. Whenever only hypertrophic changes are visualized about this joint, a careful study should be made to exclude previous supraspinatus tendon injury.

According to Throckmorton, of the various muscles which cross the shoulder joint or enter into its movements, the one most prone to strain or injury is the supraspinatus. This muscle strain may be so great at times as to produce a partial or complete rupture of the tendon or even to tear it from its bony attachment to the greater tuberosity of the humerus.

A search of the literature reveals that Codman, Wilson, Fowler, Carnett, and Throckmorton, and Keyes are the only essayists who stress the importance of supraspinatus tendon injury. Greeley also

mentions it but only as a complication of dislocation of the shoulder. This dearth of literature accounts for much of the lack of knowledge at the present time. Apparently Codman's articles were the only ones published before 1931 with the exception of Carnett's paper published in 1925 under the title of "The Calcareous Deposits of So-called Calcifying Bursitis", in which he emphasizes the importance of supraspinatus tendon injury. Codman states. "I believe that rupture of the supraspinatus tendon is the most common industrial injury causing prolonged disability and that more lost working days may be charged to it than to all the other industrial shoulder injuries combined." This is certainly a broad statement and one which is difficult to accept, but when we consider that he found one or more ruptured supraspinatus tendons in any series of twenty cadavers in the Harvard Anatomy Department, and after Dr. I. B. Akerson of the pathology staff at Harvard Medical School reported that in a series of two hundred postmortem examinations sixty-four showed some evident lesion of the supraspinatus tendon, the statement cannot be ignored. It must be noted; however, that these autopsies were performed on bodies of aged people, hence the percentage is probably higher than would be found generally. In my opinion, many cases diagnosed as bursitis, arthritis, neuritis, synovitis, and myositis are in reality cases with ruptured or injured supraspinatus tendons. Codman believes that practically all cases of traumatic subdeltoid or subacromial bursitis are due to ruptures of this tendon. Thus the importance of this entity is evident. Any prolonged disability of the shoulder with a history of sudden onset should be regarded with suspicion.

Most of the essayists on this subject fail to stress the importance of x-ray examination and imply that it is of little value except in the cases with calcifications in the tendon. It is frequently true that immediately following a rupture of the supraspinatus tendon, the roentgenogram is negative, but we seldom see these injuries until weeks or months have elapsed and there are then very definite, positive x-ray findings. Even a negative x-ray, taken soon after the injury, is of great value because it excludes conditions with which this type of lesion is confused, such as I have described, and more especially fracture of the greater tuberosity of the humerus and old calcifications in the tendon of the supraspinatus muscle.

The roentgenological findings most frequently encountered are:

1. Calcified deposits in the supraspinatus tendon, near its insertion.
2. Excrescences on or roughening of the greater tuberosity of the humerus.
3. Area of increased density in greater tuberosity at insertion of supraspinatus tendon (eburnation).

4. Roughening of outer edge of greater tuberosity below insertion of supraspinatus tendon (bursal osteitis).
5. Areas of bone absorption beneath greater tuberosity (caverns).
6. Recession of tuberosity—disuse.
7. Trabecular atrophy in greater tuberosity beneath base of bursa.
8. Hypertrophic changes at edge of acromion process.

Several theories have been propounded as to the cause of the calcareous deposits, but the one most commonly offered, and the one to which I subscribe, is that they are the result of Nature's attempt to repair tissue, with a very poor blood supply. This presupposes an injury to the fibers, of the supraspinatus tendon, hence I list calcified deposits as one of the x-ray findings in supraspinatus tendon injury. These calcareous deposits may rupture into the bursa and give a diffuse flocculent shadow throughout the area occupied by the bursa.

Since a recent book written by two orthopedic surgeons has a section on traumatic periartthritis of the shoulder in which they say. "The roentgenogram is usually negative, but may show chronic arthritis or calcareous deposits in the subacromial bursa," I think it advisable to stress the fact again that these deposits are not in the bursa but in one of the spinatus tendons or those of the other short rotators of the shoulder. In the light of present day knowledge, it would appear that the authors should have qualified their statement somewhat, at least. Careful dissection by capable surgeons well versed in the anatomy of the shoulder has fairly definitely proved this fact. If these deposits were due primarily to lesions of the bursa, it is difficult to understand why many of them are not found in the roof of the bursa. They are never found there when a careful dissection has been done. In the cases, Carnett has never found any accumulation of fluid within the bursa. This certainly speaks against any marked involvement of the bursa.

As mentioned above, most authors feel that injury to the supraspinatus tendon is the dominant feature in these cases of calcareous deposits. A dissenting voice is heard from Dickson of the Cleveland Clinic who feels that foci of infection, glandular dysfunction and metabolic disturbances are more important than trauma. It is my contention that if this is true, we should have the same x-ray findings in other articulations of the body; it seems peculiar that general disturbances of this type should confine their manifestations to the shoulder. I do not mean to belittle their value as contributing factors, but to say they are the dominant factor is, I believe, a little far-fetched. We do have an arthritis of the shoulder, probably caused by a focus of infection, and one caused by glandular dysfunction, but these give essentially the same x-ray findings as arthritis in other joints and it is not to these conditions that Dickson refers.

The second sign, roughening of the greater tuberosity of the humerus at the insertion of the supraspinatus tendon, may be due to an avulsion of particles of bone, or, in old cases, excrescences caused by chronic irritation.

By eburnation is meant an increased deposit of lime salts, probably the result of chronic inflammation. This gives the area of increased density visualized on the roentgenogram at the insertion of the supraspinatus tendon. To a certain extent the density increases with the length of time following the injury.

In old ruptures of the supraspinatus tendon, a bursitis develops and this causes an osteitis of the underlying greater tuberosity of the humerus. This accounts for the roughening of the tuberosity below the attachment of the supraspinatus tendon.

The small areas of bone absorption, which Codman calls caverns, beneath the surface of the tuberosity probably represent the early stage of the next sign, namely, recession of the greater tuberosity. This can be accounted for by disuse. The ruptured tendon no longer functions, hence there is no need for the tuberosity and it atrophies.

Trabecular atrophy beneath the base of the subacromial bursa shows as an area of decreased density. This is probably due to chronic congestion of the small vessels of the marrow spaces.

In cases of long standing bursitis from complete rupture of the supraspinatus tendon, hypertrophic changes are often seen at the edge of the acromion process. These changes probably result from the bursitis or a chronic irritation of the acromial edge by the roughened greater tuberosity of the humerus.

Perhaps the x-ray findings should be divided according to Codman's classification into those cases with complete rupture of the supraspinatus tendon, those with calcareous deposits and those with partial ruptures of the tendon; but I feel that the latter two are very closely related and except for those with calcareous deposits, a differential diagnosis by x-ray is very difficult. Hence, I prefer to list all the findings under the general head of "Injuries to the Supraspinatus Tendon."

Any discussion of this subject should emphasize the importance of good roentgenograms and proper radiographic technic and positioning of the patient. To visualize the pathology I have described, it is necessary that the maximum of contrast and detail and the minimum of distortion be obtained on the film. Occasionally soft tissue technic will be necessary and frequently two sets of roentgenograms, one with the humerus in external rotation and one with humerus in internal rotation must be taken before the examination can be called complete. If pathologic changes are not visualized in plates taken in one position, by all means take the other position. I am sure a great deal of pathology has been overlooked through failure to do this. The greater tuberosity of the

humerus is better visualized with the humerus in external rotation and since most of the pathology is near the greater tuberosity, radiographs should be made in this position first. Frequently, calcareous deposits are hidden by the head of the humerus if only one position is used. Carnett believes those cases in which the calcareous deposits disappear spontaneously in a short time are mainly due to faulty x-ray technic at the second examination. Stereoscopic plates should always be made in any x-ray examination of the shoulder. Perhaps poor plates have led to the belief of many authors on this subject that x-ray examination is of little positive value and account for the general lack of knowledge on the x-ray side of this question. It is to be hoped that a technique can be developed whereby the actual rupture can be visualized in complete ruptures of this tendon. Perhaps the solution to this problem lies in the injection of air or an opaque substance into the shoulder joint.

SUMMARY.

1. The x-ray findings in some common lesions in the immediate vicinity of the shoulder are described.
2. The importance of x-ray examination in cases of injury to the supraspinatus tendon is emphasized. The x-ray findings are described with the pathologic background for each.
3. Calcareous deposits in the tendon of the supraspinatus muscle previously supposed to be in the subacromial bursa are given as one of the x-ray findings in supraspinatus tendon injury because of the preponderance of opinion today that they result from injury to this tendon.
4. Good roentgenograms taken in the proper position are essential before pathology due to supraspinatus tendon injury can be visualized.

—(Colorado Medicine, May 1936.)

LUMBAGO AND SCIATICA.

In "The Canadian Med. Assoc. Jnl." for February 1936, S. A. Wallace says that it is the general opinion at present that lumbago and sciatica form a combined condition, and especially so in the chronic cases. The etiology of both is a fibrositis; in the one case affecting the fascial layers, muscle sheaths, and aponeurosis, and in the other, the nerve sheaths.

LUMBAGO.

An acute attack of lumbago is usually caused by a sudden strain, such as trying to get a little extra distance off the toe, or a sudden lift in the stooped position. Along with this may be a mild sort of chill, probably hardly noticed, but enough to depress the circulation through the capillaries and lymphatics so that they are unable to take care of the products of katabolism. Frequently two types are

seen—the rheumatic, with cold sweating extremities becoming purple quickly in the cold, sluggish bowels and perhaps thyroid hypofunction, and the other in the well-fed obese business man leading a sedentary life.

Chronic lumbago usually gives the history of an initial strain and exposure. Heavy laboring work tends to cause back strain, which may be aggravated by postural abnormalities. Flat feet may be a cause of backache. Constant motor driving in a badly fitting seat may be a factor. Before stating that a case is one due to strain only other conditions must be eliminated, such as tuberculous and malignant osteo-myelitis, sacralisation of the 5th lumbar vertebra, and osteo-arthritis, more frequent in persons around fifty and where the back is at all stiff.

According to Bankhart, these chronic strains are classified simply as: (1) sacro-iliac; (2) lumbo-sacral; (3) lumbar.

Sacro-iliac strain is a very frequent condition, and may become chronic, so that the original trauma is almost forgotten. The sacro-iliac joint is lined with synovial membrane and it is now thought that a limited movement may take place there. All the weight of the body passes through these two joints, and the muscles and ligaments are in use, both in lying and standing, so that in strain pain may be complained of in either position. Pain is usually referred directly over the joint and, if asked to, the patient will identify the joint line with the tip of the finger. Frequently pain is referred down the thigh, making differentiation from sciatica necessary.

Lumbo-sacral strain arises in the joint between the sacrum and the 5th lumbar vertebra. The upper surface of the sacrum slopes forward at an angle of 50 degrees with the horizontal, and the 5th lumbar vertebra tends to slip forward. Pain is usually referred over the last lumbar spine.

Lumbar strain may occur anywhere along the lumbar vertebrae, and is often found following trauma to the transverse processes and muscles.

The examination should be done with the patient stripped, and while he is standing at ease observe the general posture, the curve of the back, the shape of the legs and the condition of the feet. Next, while he is lying on the back, flex each thigh with the knee bent and see if the hip is free, at the same time watching the lumbar curve. The leg is now kept straight and lifted upward. In both sciatica and sacro-iliac strain this movement is checked by spasm of the hamstrings. Usually in sciatica pain begins to be felt when the leg is at 140 degrees, and is complained of most often in the middle of the thigh, but sometimes over the sciatic notch and also down the leg. This is called Laseque's sign. Another very useful diagnostic sign has been brought forward by Mennel. When the extended leg is lifted till pain is felt in the back of the thigh it is now dropped a

little and the foot is sharply dorsiflexed. In sciatica pain is again felt in the middle of the thigh, but in sacro-iliac strain nothing would be felt. When the leg is flexed further at the hip, in sacro-iliac strain pain is felt directly over this joint, since a rotation of the ilium on the sacrum occurs at this time. With the patient on his face hyperextension of the thigh causes pain over the joint in sacro-iliac strain. Again, while he is lying on his side, flexing the leg underneath and having him hold the knee firmly, hyperextension of the upper leg will give pain in the sacro-iliac joint if it is affected, since rotation occurs. With the patient standing have him bend forward, keeping the knees straight, and try to touch the floor. In sciatica, sacro-iliac strain or lumbo-dorsal strain, the hands might only reach as far as the knees. Since in flexion of the spine the first movements take place at the lumbo-sacral joint, in purely lumbar strain pain may not be felt till flexion proceeds and affects the upper joints. Lateral movements of the spine are usually limited in lumbar strain. Buckley has shown that in sacro-iliac strain it is impossible to bend forward and touch the toes with the knees extended, but if sitting on a low stool movement is freer, whereas in lumbosacral strain sitting does not help.

SEPTIC FOCI.

Before any treatment is begun for lumbago or sciatica a careful search for septic foci should be made. Usually this is negative. Every hospital has its invalids from multiple arthritis deformans from whom everything possible has been removed without benefit, but still there are cases in whom the removal of septic foci will produce a sudden cure. According to recent writers, septic teeth and tonsils are likely to produce fibrositis in the upper extremities, and infection of the gall bladder, bowel, pelvis and prostate might produce lumbago, sciatica and synovitis. The *S. Viridans* is the common organism in infected tonsils and teeth, the colon bacillus in alimentary and urinary infections, and the gonococcus and staphylococcus in prostate troubles. The teeth are at fault in over half the cases of septic absorption, and usually the worst cases are the apical abscesses, often discovered only by the X-ray, pyorrhoea and carious stumps being more likely to produce stomach disorders. In examining the tonsil a wooden tongue blade in each hand is useful, one to hold the tongue down and the other to massage the tonsil and see if any lumps of pus can be expressed. The infected gall bladder and sluggish bowels might have some effect on rheumatic disorders. Pelvic inflammations and an eroded cervix are often associated with backache, as is the infected prostate.

TREATMENT.

The treatment of an acute attack of lumbago consists at first of putting the patient at rest, applying large fomentations or poultices, or using a hot iron passed over brown paper. The electric pad gives

some comfort. The injection of a novocain solution into the muscle gives instant relief for a time. Dover's powder and aspirin, grs. x of each, followed by a hot drink, causes perspiration and relief. Later, infra-red treatments, with massage and analgesic liniments are beneficial. A saline cathartic is given and rich food eliminated from the diet. Hot baths are useful, and to the water may be added a pound of washing soda or Epsom salts.

The chronic cases of lumbago and back strain are more difficult to treat. In these cases adhesions are present, as after the original trauma, which may have been quite slight, an exudate is thrown out and during the period of lessened movement adhesions have had time to form. The complicated joints of the spine are more liable to locking and adhesions, and the powerful adjacent muscles are thrown into a painful spasm. During the last few years manipulative treatment of such cases has given excellent results. It is necessary to have the patient deeply anaesthetised. Mr. Bankhart, of the Middlesex Hospital, London, uses four main movements, which will be described in detail.

1. With the patient on his back, a leg is placed on the manipulator's shoulder and the hands used to keep the knee extended. The leg is now forced upward, putting the hip joint into extreme flexion. An assistant makes pressure over both anterior superior iliac spines, to keep the pelvis flat. The other leg is now similarly manipulated.

2. With the patient on the back, an arm is placed under both knees, and the thighs are brought up over the body until the knees are on each side of the head. This gives full flexion of the spine.

3. With the patient still on his back, an assistant makes firm pressure with both hands over the right anterior superior iliac spine, and the manipulator standing on the opposite side of the table, reaches over and seizes the right arm and shoulder, and pulls it forcibly forward and sideways toward him, causing a rotation of the lumbar vertebrae. It is during this movement that one so often hears the creaking of adhesions breaking down. The other side is now similarly manipulated.

4. The patient is now placed on his face and one arm placed under both thighs just above the knees; the thighs are now forcibly lifted and the back kept down by placing the free hand over the middle of the lumbar area. This forcibly hyperextends the spine. Mr. Bankhart says that the strength of an ordinary man will not do any harm in spinal manipulations.

In sacro-iliac strain one or two of the following movements are performed as well. (1) With the patient on his back, and with the affected side well over to the edge of the table so that the leg can hang over, the thigh is hyper-extended with moderate force. (2) In the same position pressure is made backwards on the anterior

superior iliac spine and forward on the tuber ischii. (3) To manipulate the left side the patient is placed on his right side and the left leg is allowed to hang over the table, and is placed between the operator's legs. The right arm is placed forward and the left arm backward, twisting the body. The operator now grasps the patient's left shoulder with his right hand, pushing it backward, and with his left hand on the iliac crest, pushes it forwards and downwards.

If at all possible, it should be the rule that no manipulations should be done without antero-posterior and lateral X-ray plates of the spine, and particularly in persons around or past middle life. Occasionally one is surprised at the pathological changes revealed by the X-ray. The differential diagnosis includes spinal arthritis with various stages of lippling, tuberculous or malignant osteomyelitis, old injuries, such as untreated compressed fractures, spondylolisthesis, long spinous processes, sacralisation of the 5th lumbar vertebra, etc. For most of the above conditions supportive appliances are necessary. During the past year or so four patients with tuberculosis of the spine have reported to me here who had been treated for rheumatism and given massage, or had been made worse by chiropractors.

SCIATICA.

The sciaticas can be grouped under two headings: (a) primary, or idiopathic; and (b) secondary, or symptomatic, e.g., sciatica in association with diabetes or that due to pressure from malignant growths. This latter group is not very common, and the treatment is self-evident. The primary cases form by far the largest number seen.

Sciatica according to recent writers is associated with or follows lumbago in 90 per cent. of cases, and one's personal experience would support this statement. The sciatic nerve has three main roots, the 5th lumbar, and the 1st and 2nd sacral. In the majority of cases the area of greatest pain is that supplied by the 5th root. In examining the course of this segment it is found that the opening between the 5th lumbar vertebra and the sacrum is much smaller than the sacral foramina through which the 2nd and 3rd segments pass, although the 5th root is much larger than the others. In consequence of this tight fit any congestion or abnormality, such as local strain in the lumbo-sacral and sacro-iliac joints, owing to the close proximity of the nerve, is liable to set up a perineural fibrositis resulting in sciatica.

On examination there is usually tenderness over the sciatic notch and between the great trochanter and tuber ischii, and always in the middle of the thigh. The pain passes down the back of the thigh and sometimes into the calf and side of the leg. In old cases there is muscular atrophy and loss of ankle jerks, and occasionally a pronation of the foot. Laseque's sign and Mennel's sign are both present.

TREATMENT.

In the acute case rest and the local application of heat with sedatives is about all that can be done. In this stage deep massage and diathermy are distinctly harmful and often lead to chronicity.

In recent years a technique for epidural injection of normal saline through the sacral hiatus has been developed, and this has proved to be by far the best treatment for chronic sciatica. The injection can be done with or without an anaesthetic, but since the majority of sciaticas are associated with lumbago it is best to use an anaesthetic so that manipulation can be done as well. The neatest and best anaesthetic for this purpose is evipal, intravenously (evipan in Great Britain). This gives a deep anaesthesia, and sleep comes quickly without struggle. It can be given in one's office and in an hour or so the patients are able to go home, but on the whole it is best given in the hospital. (It is not necessary, of course, to use evipal, as ether will serve the purpose.) The patient is laid on his affected side and the injection of an ampoule of evipal, dissolved in 10 c.c. of distilled water, is begun. It is injected at the rate of 1 c.c. per 15 seconds and after receiving 3 or 4 c.c. the patient yawns and goes into a deep sleep; about an equal amount is again given. It is rarely necessary to go above 8 c.c. although to a particularly athletic individual we gave 10 c.c. Last summer one of the anaesthetists at the Middlesex Hospital, London, told me he gave two ampoules to a Cambridge Blue before getting relaxation. The injection into the sacral canal of about 80 c.c. of saline warmed to 120 degrees F. is now begun. The sacral hiatus is felt as a depression about 2 inches above the tip of the coccyx, and is bounded on each side by the knob-like sacral tubercles. The tip of the left forefinger is placed over depression and an ordinary spinal puncture needle, or a needle of about 2 or 3 inches in length is pushed through the sacro-coccygeal membrane, with the level pointing downwards. There is considerable resistance to the membrane, and it is easy to tell when the needle passes it. The needle is now depressed and pushed directly upwards for 1 or 2 inches, and its point can now be felt in a free cavity. Aspiration is made, to see if the point of the needle is in the dural canal. The injection of the saline is made against slight resistance. The fluid passes upwards around the nerve roots, stretching the adhesions. Some time ago I injected 60 c.c. of methylene blue solution into the sacral hiatus of a cadaver, and through the abdomen exposed the lumbo-sacral nerve bundle; in the nerve sheath the methylene stain was plainly seen. After the injection, if it is thought necessary, manipulations as previously described are now done. In any case the sciatic nerve is well stretched.

If no anaesthetic is used enough novocain is added to bring the saline up to 0.25 or 0.5 per cent. In the skin and tissues down to the sacro-coccygeal membrane 2 per cent. novocain is used. If one is

unfamiliar with the insertion of the needle into the sacral canal this can be done under local anaesthesia before the injection of the evipal.

After the injection the patient is kept in bed for the remainder of the day, and sedatives given if required. The next day radiant heat and light massage are used. In only one of my cases was there a severe painful reaction. This lasted for about five days, but the final outcome was extremely good.

SUMMARY.

By this method the treatment of lumbago and sciatica has proved very satisfactory. In the past it was said that medical men could do nothing for these conditions and the sufferers drifted off, usually to the chiropractors. One can now tackle these cases with confidence, as the results are extremely gratifying.

(The General Practitioner, 1936)

SOME PULMONARY COMPLICATIONS OF ORAL OPERATIONS.

BY P. R. ALLISON

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The local complications of oral operations may cause the surgeon or the dentist sufficient concern, but being visible and easy to diagnose, though not always easy to treat, they are not associated with that intense anxiety which may be aroused by complications occurring deeply and under cover of the chest wall. There is always something rather terrifying about disease which is beyond the reach of the fingers and for which the help for some other specialist has to be invoked. In the case of the dentist pulmonary complications are a source of particular dread because the cause and effect are so often appreciated by the patient without being fully understood, and although there is no doubt that these unfortunate sequelae occur least often in the practices of the most careful dentists yet there are none to whom it may not happen at some time. The conditions which will be discussed in this paper are fat embolism, septic infarcts, pulmonary atelectasis, post-operative pneumonia and empyema, inhalation of foreign body, and pulmonary abscess and gangrene.

FAT EMBOLISM.

This is a rare condition and probably passes undiagnosed in most cases. It may follow complicated tooth extractions associated with fractures of the alveolar margins or the body of the jaw, and it differs in no way from the condition as it may occur after fracture of any bone in the body. The clinical picture is a combination of nervous and respiratory symptoms, the former consisting of unconsciousness, muscular twitchings and convulsions, the latter of cough,

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dyspnoea, pulmonary oedema and a falling blood pressure. The pathology has never been adequately worked out, but it would seem unreasonable to suppose that enough fat could enter the circulation from the site of injury to cause such a serious disturbance, and strange that, if this were indeed the case, it should occur so infrequently in a large fracture service. Lehman and Moore (1) suggest that the fat does not come from the site of injury but is precipitated from the blood as the result of an unexplained physico-chemical change. Although fat embolism carries with it a high mortality it is not of necessity fatal.

SEPTIC INFARCTS.

It is impossible to dissociate this condition from pulmonary abscess and gangrene due to inhalation of septic material and they will therefore be considered together under the latter heading

PULMONARY ATELECTASIS.

It is well known that pulmonary collapse may follow any operation and that it is most common after upper abdominal operations. Its appearances, both clinical and pathological are well recognised but the exact mode of production is still in doubt. Post-operative atelectasis does not include collapse of the lung due to pressure from without as by a pneumothorax or pleural effusion. From the anatomical point of view it may be classified into three groups; 1 Massive collapse. 2. Lobar collapse. 3. Lobular collapse.

The most widely accepted aetiological factors are the presence of tenacious secretions in the bronchi causing obstruction, diminished respiratory excursions and a dulling of the cough reflex. On this basis the anatomical classification given above depends upon the point in the bronchial tree at which the secretion lodges. Massive and lobar collapse are dramatic post-operative complications presenting no difficulty in diagnosis, but lobular collapse is more likely to be missed. To what extent this last is responsible for the production of post-operative broncho-pneumonia will be discussed later. The complication is not confined to poorly patients but occurs just as frequently in the robust and healthy. Many efforts have been made to find a single explanation for all cases of post-operative atelectasis with the result that many theories have been advanced at different times. Band and Hall (2) of Edinburgh reported four clinical cases, together with some experimental observations on dogs. In two patients the onset of symptoms was within twenty-four hours of operation and in the others it was on the fifth day. Their experiments led them to the conclusion that the important causative factors were viscid intratracheal secretions, abolition of the cough reflex and limitation of the respiratory movements.

Paralysis of the chest and diaphragm diaphragmatic infection, reflex spasm of bronchioles and angioneurotic oedema have all been

invoked, and frequently in the cases described these have been more or less important factors. Pulmonary atelectasis, however, does not follow phrenicectomy, multiple intercostal neurectomy or stimulation of the vagus nerve. It follows operations not involving the diaphragm, and its frequent localization to one lobe or one lung precludes the angioneurotic theory as an explanation for all cases. The evidence is in favour of its production by the lodging of one or more masses of tenacious bronchial secretion in such a way that a "stop valve" is produced. Air can pass neither in nor out past the obstruction with the result that that already contained in the alveoli is absorbed into the blood-stream and collapse of the lung follows. The factors concerned in the production of pulmonary atelectasis must therefore be those which inhibit the removal of the mucous plug from the bronchus. Inflammation or paralysis of the diaphragm, a tight binder round the chest, inhibition of the cough reflex by morphia or by pain, thickening of the secretions by the use of atropine may each or all of them be responsible in a given case.

The clinical manifestations of massive pulmonary or lobar collapse are dramatic enough to command immediate attention. A patient who hitherto has progressed satisfactorily may suddenly be seized with pain in the chest and dyspnoea of such severity as to suggest a pulmonary embolus. He becomes cyanosed, the respirations are rapid and shallow, the pulse rapid and the temperature elevated. Physical examination reveals dullness to percussion, greatly diminished air entry and displacement of the heart and mediastinum towards the affected side. If an X-ray examination can be made the collapsed lung or lobe appears as a uniform opacity, the mediastinal displacement is confirmed and compensatory emphysema of the other lung is noted. When the above symptoms and signs follow an oral operation it is extremely important to exclude an inhaled foreign body as the cause of the bronchial obstruction and this can be done only by the most careful X-ray and bronchoscopic examination. Tucker and Wolfarth (3) have reported the case of a child aged 13 years in whom haemoptysis was caused by a head of Timothy grass which had been inhaled five years previously. Bronchoscopic removal was followed by complete atelectasis of the affected lung and a second bronchoscopy proved this to be due to aspirated secretions of the same kind as those which had been found distal to the foreign body. From the point of view of the dentist and the oral surgeon prophylactic measures consist in meticulous precautions for a free air-way during anaesthesia and the early stimulation of the cough reflex after operation. This precludes the use of post-operative morphia. When atelectasis occurs and the presence of a foreign body has been excluded the treatment consists in the administration of carbon-dioxide and oxygen to stimulate respiration, forced coughing, and bronchoscopic aspiration of retained secretions. The

administration of an emetic will sometimes clear the bronchial tree when other measures have failed,

POST-OPERATIVE PNEUMONIA AND EMPYEMA.

True lobar pneumonia is an uncommon complication of any operation. Broncho-pneumonia on the other hand does occur frequently and seems to be particularly liable to follow operations on the upper respiratory passages. It is generally supposed that there is no relation between atelectasis and post-operative pneumonia, but this attitude is open to criticism. Many cases of atelectasis are wrongly diagnosed as pneumonia, and in fact there is a widespread tendency to regard any respiratory disturbances after operation as pneumonia. The distinction between the two lesions is very important from the prognostic point of view because atelectasis is so eminently responsive to the simple therapeutic measures already described. Lobular collapse cannot be diagnosed with accuracy during life and so it is difficult to deny that this may be an early stage in the production of broncho-pneumonia.

When pneumonia is once established there is at once opened up a whole chain of possible complications such as lung abscess and empyema. If post-pneumonic abscess occurs a very careful record of the illness is the only way to differentiate it from abscess and empyema secondary to the inhalation of septic material.

INHALATION OF FOREIGN BODY.

The most common foreign body to be inhaled during dental operations is of course a tooth, but amalgam fillings and dental instruments have also been recorded as finding their way into the bronchi. In 1927 from the Chevalier Jackson Bronchoscopic Clinics Gabriel Tucker (4) reported a number of cases of inhaled foreign body following operations on the nose and throat, and these included a lamp from a mouth-gag, a catch from tonsil forceps, a tonsil snare wire, a gold tooth crown, a tonsil sponge, a portion of a nasal rasp, an inhalation tube, a wooden applicator and swab, and five cases in which a deciduous tooth was inhaled. Foreign bodies are found in the right bronchial tree twice as commonly as in the left because the former is the more direct continuation of the trachea. Once a foreign body has entered a bronchus it may act mechanically in one of three ways and the resulting clinical manifestations vary accordingly. In the first place it may form a check-valve so that air can pass beyond it into the lungs but cannot escape back again. In these circumstances the respiratory distress is associated with gross emphysema of the affected lung or lobe with displacement of the mediastinum towards the normal side. Secondly it may form a by-pass valve, and thirdly it may block the bronchus completely. In the last case atelectasis occurs and the signs are those which have been described above. If the body is not removed or coughed

up it may become encysted or it may lead to bronchiectasis, lung abscess or mediastinal abscess.

Early bronchoscopic removal is the ideal treatment and if the body has descended too far into the bronchial tree to allow of this being done under direct vision the operation may be performed successfully with the aid of the bi-plane fluoroscope. In some cases removal by open operation is justifiable.

ABSCESS AND GANGRENE OF THE LUNG.

The distinction between abscess and gangrene of the lungs is rather a matter of the rapidity of spread of the infection, the amount of resistance, and the infecting organisms. The two conditions may conveniently be described together. It is obvious that a lung abscess may arise from the breaking down of a septic infarct following operation, and it also seems certain that an exactly similar condition may follow the inhalation of septic material into the bronchial tree. Which of these processes is most often the cause of a post-operative lung abscess is still a matter of dispute, but the consensus of opinion seems to be in favour of the latter method for most cases. If a large series of post-operative abscesses be considered, it is found that a gross foreign body is not a common causative factor. In the great majority of cases where this can be excluded it is supposed that the abscess arises from the inhalation of infected blood clot and pus from the upper respiratory passages. In favour of this hypothesis it may be noted that the organisms cultivated from a lung abscess frequently correspond with those found in the mouth and that this is true even when the operation has been below the diaphragm.

In a series of bronchoscopies performed after tonsillectomy under general anaesthesia, Myerson (5) found blood below the vocal cords in 76 per cent. and Iglauder (6) obtained similar findings in 20 per cent. of fifty adult patients submitted to tonsillectomy under local anaesthesia. Although the use of local anaesthesia for oral operations has greatly diminished the incidence of pulmonary abscess, it has not eliminated it, and it is important that all the factors concerned should be thoroughly understood in order to minimise the possibilities of this formidable complication. After the application of a local anesthetic, during deep sleep, or during narcosis, substances placed in the back of the mouth can easily be inhaled into the bronchial tree, and if the substance be of a non-irritating nature, this may occur even during consciousness. In a great number of patients, it is possible to drop lipiodol from a syringe over the back of the tongue into the bronchi without any anaesthetic, and this method is extensively used for bronchography. It seems, therefore, that a patient who takes a narcotic after the extraction of septic teeth is running an appreciable risk of aspiration abscess. Moore (7) analysed a series of two hundred and two cases of lung abscess following operation on the upper respiratory passages; of these only

five followed dental extraction, and thirty-nine occurred with the use of local anaesthesia. 60 per cent. were found to affect the lower lobes and the lesion was twice as common on the right side as on the left. From the point of view of both treatment and statistics, it is very important that abscess of the lung should be accurately localised, and a glance at many reports shows that the relation to the various lobes has too often been dependant upon a simple antero-posterior X-ray plate. An abscess in the antero-inferior angle of the upper lobe may appear on the straight X-ray to be in the lower lobe and close to the hilum; it is only after a plate has been taken in the lateral position that the true relations can be made out. Useful measures in the prophylaxis of abscess following dental operations have been summarised by Stern (8). He recommends before extraction high pressure irrigation of the interdental spaces, the use of dental floss, removal of tartar, use of oxidising mouth washes and a minimum amount of local anaesthetic. He suggests that extractions should be done in the morning so that bleeding and discharge have ceased before the patient goes to sleep at night and that the operation should be done with the patient in the prone position. This last suggestion is directly contrary to the practice of nearly all dental surgeons, but it merits their serious consideration. The ideal position for the prevention of inhalation of material from the mouth is, of course, where the head is below the level of the chest.

Post-operative lung abscess presents a very typical clinical course, which can be divided into three stages. In the primary stage, the patient may not complain of any symptoms for about ten days to two weeks after the operation, although during this time, he feels that he is not recovering as quickly as he should. After this time, he experiences a stabbing pleuritic pain and a dry irritable cough. He becomes febrile and then suddenly his cough is accompanied by the expectoration of a large quantity of foul pus. From that time he suffers from persistent expectoration, sweats and a temperature of 102° to 103°F. If drainage is satisfactory he gradually improves. It has been estimated that 23.5 per cent of cases show spontaneous cure. The second stage is one of the remission of relapse. The patient gains weight and becomes free from symptoms for a variable time, and then cough and expectoration return often with the addition of haemoptysis. During this period clubbing of the fingers appears and the x-ray shows persistent infiltration of the lung parenchyma. After three or four months bronchiectasis develops and the third stage is entered. When once the patient has been allowed to reach this stage the expectation of life in the absence of radical surgical removal of the affected lobe is about three years. Death usually comes from broncho pneumonia, pleural or pericardial infection, haemorrhage, amyloid disease, or metastatic abscesses in the brain, kidneys, or long bones. The best opportunities for treatment are in

the primary stage, and success depends upon accurate localization of the abscess with respect to the bronchial tree, continuous postural drainage, and maintaining the patency of the affected bronchus by bronchoscopy.

University of Leeds Medical Society Magazine, Oct. 1936.

INTRA-NASAL OXYGEN THERAPY

BY H. K. SPEED, M.D., *Sayre.*

History: The subject in question is one that I feel has been very much neglected. Oxygen as a therapeutic agent has been employed for many years. Until recently, the last three or four years, the method of application has been too bunglesome and expensive to be of any great value except in liberally endowed institutions.

It was, I believe, first used by means of an oxygen chamber which cost from three to five thousand dollars per unit, and later by an oxygen tent, many models of which are on the market, all of which are rather expensive, both in the initial equipment and in the use of oxygen. Too much detail of a technical nature is required to maintain a person in either of these above mentioned methods.

Administration: The simplest way to administer oxygen is by a small caliber, ten or twelve French gage, rubber catheter inserted into the nostril about four and a half to five and a half inches from the alae of the nose. It is passed back to where it is visible behind the uvulae and then withdrawn just out of sight. The catheter is then fastened by adhesive straps to the surface skin of the face.

The apparatus for this administration can be made by any country doctor with a little bit of effort and an outlay of about two dollars' expense. Any welding establishment, one of which can be found in any country, handles pure commercial oxygen. For the dispensing of its contents there is a special gage, several types of which are available at a cost of from ten to fifteen dollars, that will regulate the flow as desired.

The oxygen is conveyed through a rubber tube into a gallon bottle nearly filled with water. The oxygen is released under water through the glass tube to insure saturation of the gas with moisture. This bottle is connected from above the water to a second bottle containing no water, through which the gas is passed to remove any excess of moisture, making certain that free liquid will not be carried into the patient's lungs.

A glass tube from the second bottle is connected to a rubber tubing which is likewise connected with the soft rubber catheter in place in the patient's nostril.

Care should be taken not to connect the gas with the catheter until the desired flow is started for fear there will be too sudden flow of gas when it is turned on. It should be regulated so that there

will be just short of a continuous stream through the water. In other words, a constant flow of bubbles of oxygen through the water in the first bottle.

Concentration: This amount will give the patient from four to six litres per minute, which has been found to be about the proper amount for the best results. To get proper therapeutic effects the patient must receive in the neighbourhood of about thirty-five per cent or more oxygen in the air. Anything under thirty per cent seems to be of practically no therapeutic value.

By the above method it is found by a careful test that from thirty-five per cent to even as high as seventy-four per cent oxygen can be delivered to the patient's pharynx. Of course, for a seventy-four per cent delivery there must be liberated something like fifteen litres per minute, which is excessive and unnecessary.

Wisconsin General Hospital: We by no means claim any originality of this method. It was brought to me by my son who interned in the Wisconsin General Hospital, Madison, where it is extensively used. In fact, they have one hundred and twenty-eight rooms in their hospital piped for oxygen which is used exclusively by this method.

Many of you gentlemen will, no doubt, remember Dr. Waters, chief anesthetist of that hospital, who demonstrated this same type of apparatus before the Oklahoma City Clinical Society last fall.

Uses of oxygen:

1. Makes breathing easier and gives more comfort thereby.
2. Slows pulse and respiration and lowers temperature in fibrile cases.
3. Increases arterial oxygen saturation and relieves cyanosis.
4. Often prolongs life until immunity can be built up to make recovery possible.

Most common failure in oxygen therapy where otherwise success could be had:

1. Procrastination in beginning the medication.
2. Improper administration.
3. The expense attached thereto.

Procrastination: In the first instance you should not expect much relief from the administration of any therapeutic agent in a moribund patient. Therefore, begin your oxygen early when the pulse rate or respiration becomes accelerated. And, if possible, before cyanosis appears. If you are not able to begin it before cyanosis appears, begin it as soon as possible thereafter.

Improper administration may be had by the catheter being placed too far down in the pharynx, causing irritation. Or not far enough down, causing escape of the gas, or an improper or not sufficient flow of gas from the tank.

Expense: The expense is not a big item. The average container, which costs five dollars, ordinarily will last five days. It is seldom

necessary to continue its use more than the length of time it will take to empty two tanks.

Oxygen therapy is especially useful:

1. Pneumonia, both lobar and bronchial.
2. Post-operative collapse of the lung.
3. Asthmatic paroxysms until other therapeutic agents can take effect.
4. Atelectasis of the newborn.
5. Emphysema.
6. Fibrosis of the lung with acute oxygen want.
7. Asphyxia of any kind, especially if used with carbon dioxide.
8. Congestive heart failure.
9. Coronary thrombosis and angina pectoris.

Pneumonia: We feel as if the greatest field for oxygen therapy by the nasal catheter method is in pneumonia, because we have that widespread over all the country and in the hands of many men who do not have access to a hospital. We feel as if many lives can be saved from this dreadful disease if one of these simple apparatuses could be put in the hands of every practitioner in the country.

During the last two years my son and I, in our private practice, have treated some forty cases of pneumonia by this method. We have found that almost invariably after beginning the administration of oxygen the temperature, pulse, and respiration are materially reduced. If the patient is cyanotic but not moribund, the cyanosis almost invariably disappears within a short time. The patient will tell you within a few minutes that he feels better.

Some clinicians say that oxygen should be begun when cyanosis is evident and continued in sufficient concentrations to keep the finger nails pink. Our experience, and that of many men who have had vastly more experience, is that it should be given before there is an onset of cyanosis and anoxemia, which is evidenced by high temperature, rapid pulse, and increased respiration.

The pulse rate should be a better index than cyanosis for the amount or time to begin oxygen. After cyanosis has developed, much more damage has been done.

When the discontinuance of oxygen is anticipated, it should be brought about gradually. Otherwise there is likely to be a severe reaction as evidenced in mountain sickness where going from a low to a high altitude. In cases where the heart has been materially impaired this might even prove fatal. Also the temperature, pulse, and respiration are likely to rise again.

Coronary occlusion: In acute coronary occlusion or any congestive heart failure where there is cyanosis and dyspnoea, it will often tide the heart over until it can be adapted and regain its equilibrium.

Chronic cyanosis: It should not be used for the mere fact that there is cyanosis. To do so may produce in the patient an intolerance for its discontinuance.

Angina: In anginal pains where the cause is general and not localized in a small area of the heart muscle, the pain is very readily relieved. If it is not readily relieved you may be certain that it will not be benefitted by oxygen therapy.

Asthma: Where the paroxysms are severe inhalations of oxygen in a concentrated form will often give almost immediate relief, thereby making the patient comfortable until other therapeutic agents can be employed.

Asphyxia: In an obstruction of the air passage as by a foreign body or laryngeal diphtheria, death often comes from air hunger which seems out of proportion to the obstruction, or the infection in laryngeal diphtheria. Oxygen therapy is very useful in these cases if used before the resistance is broken down.

I believe no one claims a specific therapeutic action for oxygen therapy. It acts somewhat like glucose in maintaining the resistance, especially in edema of the lungs and anoxemia, which, if left alone, will further break down the resistance. By a liberal use of a concentrated flow of oxygen it has been many times demonstrated that this resistance can be redeemed until the body can build up sufficient immunity to the toxins to prolong and save life.

Extracts

REPEATED CESAREAN SECTION COMPLICATED BY RUPTURE OF THE UTERUS A FEW MINUTES BEFORE OPERATION.

The general surgeon finds it necessary sometimes to express an opinion with reference to the advisability of operative procedures in connection with obstetrical situations. With that in mind, this article by Gerin-Lajoie is not only of general interest, but indicates the particular wisdom of paying attention to the possibility of accidents in the case of pregnancy following repeated Cesarean sections.

A woman about twenty-five years of age, pregnant eight months, entered hospital April 28, 1934, about eight p. m. She came because she had had pains since noon of the same day—a period of eight hours during which she continued the performance of active duties about her home.

There had been five previous pregnancies at term. In the first two forceps were employed, the delivered infants being dead and mutilated. In the three following Cesarean sections were done, all infants living.

Measurements showed greatly contracted pelvis.

On admission, the fetal heart rate was 110. Fifteen minutes later it was 140. An hour later as patient was being taken to operating room it was 60 or less.

The abdomen was opened. There was much free blood in peritoneal cavity. After rapid separation of adhesions following the former operations, it was discovered that there was an extensive rupture of the uterus at the site of scar tissue in its walls.

The fetus was in upper abdomen. Efforts to resuscitate after rapid delivery were unsuccessful.

A subtotal hysterectomy was performed. Patient was not doing well. A Mickulicz pack was put in to central oozing. A few wicks were placed for drainage. The abdomen was closed by through and through sutures. Physiologic saline solution was given intravenously. Rapid improvement. Discharged on eighteenth day after operation.

The article is terminated with the emphatic warning that the pregnant women who has had a Cesarean section, and particularly if she has had multiple sections, ought to report at the moment the first pains are noticed, even if it should be several weeks or a month before the time of expected confinement. In that way only can the best interests of mother and infant be safe-guarded. To be more explicit, the author indicates that in the case of pregnancy following multiple sections operation ought to be done as soon as possible after the beginning of labor pains.

Comments: Looking at the matter from the point of view of the patient's best interests, the employment of through and through sutures for closing the abdomen when the patient is in shock is to be commended. As a matter of fact, it is a very satisfactory way to close the abdomen in any case, provided the sutures are properly placed.

The Mickulicz pack is of great service when there is troublesome oozing in the pelvis. It probably should be employed more often in this country.

THE TREATMENT OF CARCINOMA OF THE CERVIX.

BY WERTHEIM'S OPERATION. VICTOR BONNEY, LONDON, ENGLAND.
The American Journal of Obstetrics and Gynecology, Dec. 1935, Page 816.

(Comment: There is a tendency, particularly in this country, to look upon radiation as the only adequate treatment for carcinoma of the cervix to-day. There is also the feeling that any advance in the treatment of carcinoma of the cervix will be along radiological lines, and that operative treatment has no place in the care of these patients. No one can foretell the future improvements in the treatment of carcinoma of the cervix. Certainly the facts, such as contained in Mr. Bonney's work, demonstrate the hazards of hastily

discarding and abandoning all operative measures. That a combination of a surgery and irradiation may be the best treatment is certainly within the bounds of experience and reason, though at the moment we look upon irradiation treatment as the best one applied to our present circumstances.

It is particularly valuable, therefore, to review the work of Mr. Bonney who is probably the most capable man in the world in the performance of the Wertheim operation and who has consistently since 1907 done this operation in at least sixty-three per cent of the patients with carcinoma of the cervix that he has seen.)

Mr. Bonney has given his results upon the basis of five years freedom from recurrence and afterwards upon the basis of ten years freedom of recurrence, because he states that ten per cent of all recurrences appear between the fifth and tenth year. He has classified his cases according to whether the regional glands removed at operation were or were not carcinomatous.

The incidence of regional gland involvement in his series of cases is forty-two per cent.

Mr. Bonney has performed the Wertheim operation four hundred eighty-three times. Confusion with irradiation treatment is avoided because the very few cases operated upon who had had pre-operative or post-operative irradiation were all dead at the end of five years. He has operated upon sixty-three per cent of all the other patients seen—that is, an operability rate of sixty-three per cent.

Of three hundred eighty-four patients reported on the basis of five year freedom from recurrence, one hundred fifty were living and well, or a five year cure rate of thirty nine per cent. In this group one hundred fourteen had no gland involvement and were well at the end of five years—that is, a cure rate of fifty-one per cent. Where the glands were involved, cure rate of fifty years was twenty-two per cent.

Of the two hundred eighty-three patients reported upon the basis of ten year results, eighty-two were living and well at the end of ten years, or a ten year cure rate of twenty per cent.

Mr. Bonney reports "actual operative achievement" upon the basis that he has operated upon sixty-three per cent of the patients seen. On the basis of five years freedom from recurrence he reports his actual operative achievement at 24.6 per cent. On the basis of ten years freedom from recurrence his figures show eighteen per cent. In Mr. Bonney's experience quite a large number of patients were lost sight of in the follow up and they are reckoned in the above figures as having died of recurrence. With such a large number he feels that it is not quite fair to assume that all of these patients have so died. Of course, in the event that they are not so calculated the

results are considerably improved. He feels, also, that when sixty-three cases are operated upon out of a hundred there will be a few cures in the remaining thirty-seven, which will be treated by irradiation, thereby increasing the total number of cured out of a hundred.

Comment: Despite the very decided statements made by some gynecologists and radiologists concerning the treatment for carcinoma of the cervix, most of us feel that the ultimate perfection has not yet been attained and that by no means need it be limited to a consideration of improvement along radiological lines alone. Mr. Bonney's contribution has been a very valuable one in determining the experience to be expected in expert hands with pure surgery alone.

Medical News and Notes

MALABAR MEDICAL ASSOCIATION.—The sixth annual general meeting of the Malabar District Medical Association was held on 11th April at the Calicut Town Hall under the presidency of Major J. F. Sheppard. A large and distinguished gathering was present.

Captain A. R. Poduval delivered an interesting speech on the occasion. He was glad that there was much co-operation between medical men in Malabar. He also laid great stress on the part that faith plays in effecting a cure. He regretted the tendency on the part of certain surgeons to resort to surgery even in cases where a cure could be effected otherwise. Captain Poduval also hoped that before long a cure could be found for the deadly scourge of cancer which was working such havoc on humanity.

Office bearers for the new year were then elected. Dr. Navaneetha Krishnan, District Medical Officer, was elected president and Dr. V. Krishna Menon, Secretary.

KARAIKUDI MEDICAL ASSOCIATION.—At a general body meeting of the Ramnad District Medical Association held on 10th April at the S. M. S. Vidyasala, Karaikudi, Mr. F. Ysander, M.D., presiding, the following office-bearers for the year were elected:—

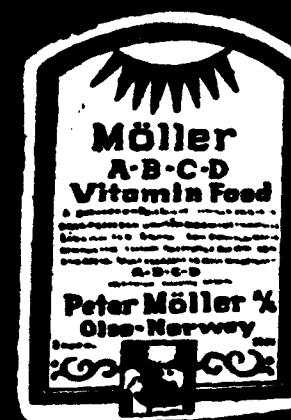
Captain B. Dayananda Rao, A.I.R.O., District Medical Officer, Ramnad, was elected President, Dr. F. Ysander, M.D., re-elected as Vice-President, while Dr. K. S. Srinivasan, L.M. & S., and K. R. Ratnasami were elected as Secretary and the Joint Secretary of the Association. Dr. S. Subramanyam of Karaikudi was re-elected Treasurer. Messrs. E. Ivetts, Dr. T. S. Shetty, S. R. Bharathi and N. Krishnaswami were elected to form the committee members and Messrs. M. S. Venkateshan and R. Bhimsingh as the auditors of the Association.

PRIVATE DOCTORS IN TINNEVELLY.—The inaugural address of the Independent Medical Practitioners' Association, Thinnevelly, was delivered on 10th April by Dr. T. N. Govinda Aiyar, a senior

practitioner of this place, on the subject of the "Art of Private Practice."

In the course of his lecture, he said that only those with registerable qualifications should be permitted to practice. He said that both the general and special practitioners must have a thorough equipment. Referring to the general practitioner, he said that he must have, besides the thermometer and stethoscope, the blood-pressure instrument, a microscope, auroscope and Ophthalmoscope. The specialists also must have complete equipment in their line.

Dealing with the relationship to fellow doctors, Dr. Govinda Aiyar said that the rules of medical etiquette should be strictly followed. Consultants should remain as consultants only and not encroach on the field of general practitioners. Proceeding, the speaker said that the practitioners should exercise great care in their relationship with patients, to whom they must show great consideration and friendly and sympathetic attention. Patients must be attended to at all times. Every practitioner must have a settled scale of fees for all, though concessions could be shown to poor people.



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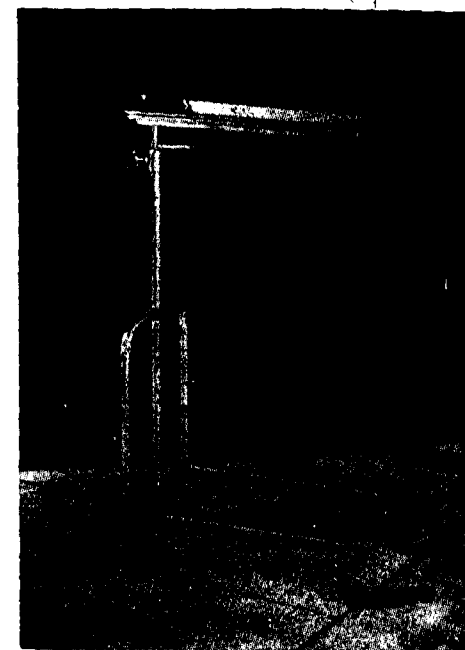
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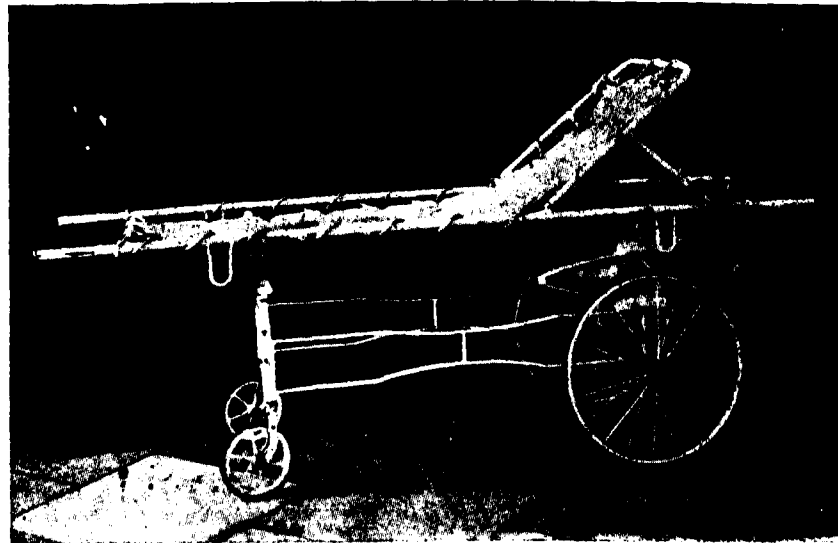
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