"CONCRETIONS & CALCULI OF THE LUNGS & BRONCHI"

by

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Whilst acting as a Resident Medical Officer at a hospital for consumption and diseases of the chest some time ago, I was one morning shown by a patient a small, irregular-shaped, stony mass which he said he had brought up with his expectoration. He was considerably alarmed at this new feature in his condition, fearing that it was a grave symptom. Although at that time I certainly had never seen a concretion or calculus which had been expectorated, I was of course aware that tubercular masses in the lungs frequently underwent calcification in process of healing; and assured the patient that it was a favourable symptom rather than a cause for alarm. I may say from what I have since learnt that I have had reason to considerably modify that opinion. Subsequently, two other cases of patients expectorating pulmonary calculi came under my notice, and led me to the investigation of this subject; the results of which are given in the following pages.

To the ordinary practitioner, this is, I believe, a somewhat rare condition, and indeed our English medical literature contains comparatively few cases. In the French and German medical literature the cases reported are more numerous, and the analysis and investigation of the principal of these, together with those in our own language, and those which came under my own notice, have formed the basis of this paper.
Historical:— The existence of stony products found in the lungs, or brought up by coughing is of very ancient date. Hippocrates, who studied with minute attention all that pertains to the expectoration, does not however appear to have been acquainted with them.

Aristotle (Historium Animalium VII De partibus lib III, cap IV) is the first to mention them. It was his duty, at the request of Alexander the Great, to make post mortem examinations on a great many animals for the purpose of anatomical study and description. In these different researches he remarked that occasionally the lungs of sheep presented stony indurations resembling calculi of the kidneys and liver.

Galen (De locis affectis lib. IV, cap IX) refers to some patients who coughed up some small calculi. He had noted the expectoration of humour, and thought that the calculi became formed in the bronchi by the drying and hardening of this fluid. "Conjeci, lentem humorem, quem antea expuere solebat, siccatem induratunque, ad hujus modi substantium pervenisse."

Alexander of Tralli (lib IV, cap IV) reports the case of a man who occasionally expectorated some calcareous concretions.

Paulus of Aegina witnessed the expectoration of several stony concretions, accompanied by haemoptysis.

These observations are reported by their authors as rare and curious facts, and so in a great number of
others published in the medical works of the 16th century. The chief of these are Benevenius (1506 De abditis cap 24) Fallopius 1561. Fernel (Pathology 1564 lib V, cap 10) etc. Sometimes they treat of concretions found P.M. and most probably of tuberculous origin. Most of these authors do not discuss the nature of these formations, but accept the theory given by Galen of the drying up of bronchial humours.

In 1600, Scheeneck of Grafenberg, in an important work on pathological anatomy, gives a chapter (De calcis in pulmonalibus) to concretions and calculi of the lungs. He collected the principal observations of the earlier writers, and relates a number of other facts observed in his day.

During the 17th century numerous observations were published. Saxonia (lib II, cap IV). Thomas Bartolin (Anat hist p 49). Willis (Pharm. Prat. 1677, cap VI). Ricard Morton (Phthisiologia 1678 De phthisis calculis in pulmonalibus generatis) acknowledges in his classification of the species of phthisis. "pulmonary phthisis produced by calculus."

In 1744 Herman Boerhaeve (Prelectiones Acad. VII p 222) speaking of stones expectorated by coughing, reports the case of a botanist, Sebastian Vaillant, who expectorated during his life, nearly 400 calculi, and who died at the age of 53 with signs of calcareus phthisis.

In 1761 J. B. Morgagni, the illustrious pupil of
Valsalva, Professor at the School at Padua, collected and arranged his observations (Die sedibus et causis morborum per anatomien indigitates) for his clinique in regard to the relation of the alterations found after death, with the signs and symptoms observed during life. With this idea he wrote his chief work on the cause and seat of diseases, in which he gives one chapter to the consideration of stony products of the lung. In this letter (XV) addressed to his friend William Bromfield of London, Morgagni describes chiefly the respiratory trouble resulting from the presence of calculi or concretions in the lung. He says that he considers the subject worthy of being treated with more care. He distinguishes between parenchymatous concretions and indurated glands, and intra bronchitic concretions resulting from the condensation of fluids secreted by the mucus tissue of the respiratory channels.

In 1789 Meckel (Neues archiv der pratischen Arzniekunst) and Matthew Baillie (Morbid Anatomy) describe several new cases observed by them.

Cullen (Eléments de médecine pratique) points out a special form of asthma caused by bronchial calculi, which he names "Asthme calculeux."

In 1810 Bayle (Recherches sur la phthisie pulmonaire) reduces the numerous species of phthisis which his predecessors recognised, to six. Amongst these is calculus phthisis, which is described by him as a lesion apart from tubercle.
In 1819 Laennec abolished all preceding distinctions, and established the unity of the various forms of phthisis from the anatomical and clinical point of view. Thenceforth calcareous lung deposits were regarded as "une mode de transformation de la matière tuberculeuse comme un produit des efforts de la nature pour amener la guérison de la phthisie."

The matter seemed definitely settled, and the question of calculi of the lungs apart from tuberculosis appears never to have been raised.

But in 1854 Professor Forget of Strasburg took a stand against this idea as being too arbitrary, and wrote a monograph with the object of showing that there was a calcareous phthisis, non-tubercular, and independent of mineral dust. In support of this opinion he brought forward three cases of patients who were suffering from all the symptoms of consumption, but who recovered after expectorating calculi.

Virchow writing in the "Archiv für pathologische anatomie und für Klinische Med," in 1855, contends that the calcareous deposits in the different organs, and notably in the lungs, are most often due to an exaggerated production of phosphate of lime in consequence of osseous lesion, and at the same time to a defect of renal excretion.

The above is a brief outline of the history of the literature on pulmonary and bronchial concretions and calculi, up to comparatively modern times.
I shall next propose to consider the process, theories, and pathology of calcification in general; and then the various concretions found in the lungs, and bronchi. These will be divided into three main heads, namely:

Chondrifications, Ossifications, Calcifications.

These latter being by far the most numerous and important will be divided into subsections, having regard to their site, nature, etc.

calcification: We speak of calcification when undissolved lime salts are present in the tissue, but without having entered into such close combination with the organic substance of the tissue as is the case with bone. The earthy salts in calcification are simply mixed with the tissues, the latter being impregnated with them just as they are with silver in cases of argyria. The salts are the same as those forming the inorganic part of bone, namely calcium phosphate, with usually smaller quantities of carbonate, and, as a rule, traces of phosphate and carbonate of magnesium. If the calcareous particles are numerous, the affected part has a whitish colouration, but even when most extreme it is not likely to be confounded with true bone, since there are no bone lamellae or bone corpuscles.

On dissolving the salts with an acid, the original organic tissue may in many cases be seen. We know that lime salts are derived from the food, and chiefly from vegetable food, and that they are present in the
blood and lymph streams. What is the precise cause which determines their precipitation so as to produce a calculus or concretion, is not easy to accurately decide. The idea which first suggests itself is that it is due to a precipitation of the lime salts of the tissues, which salts were previously in solution. There is hardly a single tissue in whose ash one cannot detect the same earthy salts which compose the pathological incrustations. If the matter admitted of so simple a solution, there would only then remain to discover the cause of the precipitation of the salts, such as the disappearance of the solvent. But this is not so, since we know that the ash constituents of the tissues that are richest in inorganic salts (excepting of course bones and teeth) amount to about 1 or 2 per cent, whereas a calcified artery, for instance, leaves a residue very little short of the original tissue. (Cohnheim) Therefore we must conclude that the salts of calcification must be conveyed to the part affected and deposited in it.

Virchow in his "Archives" VIII & IX alludes to Metastatic calcification or "Lime metastasis," in connection with the absorption of lime salts from bone, and their transference to other regions. What Virchow specially determined was the very unusual situation of the calcification, for it always involved parts of the lungs or digestive canal; and here the connective tissue of the affected patches was so infiltrated with
lime salts that it felt like pumice stone. No doubt a special condition must exist to cause the precipitation of these salts in the affected localities.

Many of the older writers refer to the presence of carbonic acid in the fluids, and thought that its presence was responsible for the non-deposit of lime salts in the veins, whilst they were deposited in the arteries; but the invariable absence of calcification in the pulmonary veins where the carbon di oxide tension is lower than elsewhere, dispels this theory.

We know that the deposition usually occurs in diseased tissues, especially in those which are the seat of vascular disorders, and that local necrosis or fibrosis antedate intercellular calcification. It has been pointed out by Weigert (Arch A L XXIX) and others, that there is always present in the middle of a sclerotic area a small portion without nuclei, where the tissues have succumbed to coagulation necrosis, and that in the tunica media of the arteries of old persons, there are always some muscle fibres without nuclei, and in a condition of necrosis.

Fibrin is often present, as in thrombi, infarcts, and endocarditis. We know also that vascularity or rather avascularity seems in many cases to be an assisting cause, and that most of the substances which undergo calcification have suffered from impaired nutrition.

Microscopical examination shows these salts as fine granules scattered through the intercellular substance. Cellular infiltration however is not uncommon, and in
such instances the cells show more or less extensive nuclear and protoplasmic degeneration. By coalescence of the granules larger irregular spherical bodies are formed. Fibrosis, cellular necrosis, and degeneration may be demonstrated in the tissues by suitable methods. (Stengel.)

Hyaline and fatty changes often precede and accompany calcification. The soluble calcium salts are present in the blood and lymph as lactate or glycerophosphate of lime, and then become converted into the insoluble carbonates or phosphates.

Litten, whose summary is quoted by Virchow, says "Calcification is the result of a change in the chemical constitution of the albuminous substances associated with their death or obsolescences, and the lime salts become arrested where such changes occur.

But in addition to the above necrotic changes, or the changes due to reduced energy, there are other agencies which in most, if not all cases, take an active part in the precipitation of calcareous salts. These agencies are of bacteriological nature.

It has been found that the formation of biliary calculi is at least not purely chemical. It is held that micro-organisms are in a large measure responsible for the changes in the mucous membrane of the biliary passages which lead to the formation of gall stones.

Chiari, Sherrington and others have shown in typhoid and anthrax, that bacilli are frequently found
in the gall bladder. Itala experimented on these lines. He found that cultures of attenuated B. Typhosus, and B. Coli when injected into the gall bladder of animals, induced an acidification of the bile, whereby cholesterin is precipitated. This mixes with the mucus secreted by the wall of the gall bladder, and a mass is formed resembling in appearance and composition a gall-stone. A similar result was not obtained with killed bacilli, so that the action is not purely chemical.

In regard to the formation of renal calculi, it may also be mentioned that Tuffer found that foreign aseptic bodies are not altered by a sojourn in the normal urinary passages, even though a phosphatic, uratic, or oxalate diet be given.

The concretions met with in the mouth and appendages have been attributed to bacteriological action. That is odontoliths, salivary calculi, and stones in the crypts of the tonsils.

Maas, Waldeyer and Klebs (A & exper Path V p 350) microscopically examined these after decalcification of the earthy salts. They found in all an organic basis consisting of dense colonies of bacteria.

Klebs believes that a leptothrix has the power of separating out the lime from all its combinations.

The late Professor Kanthack sums up a short observation on this subject of calcification, as being due to:

1. Stagnation.
2. A nucleus of some sort
around which deposition takes place. 3. Changes in
the chemical composition of the fluids, and in their
solvent power which are often due to bacterial activity,
and to an increase in albuminous, mucous, and colloid
substances.

In addition to the above reasons, most observers
refer to the natural tendency which some people have
to the formation of calculi; the "calculous diathesis"
as it has been called. Notthagel cites a case in
support of this, and there is one well authenticated
case at least, of the deposition of urates in the
bronchial wall in a gouty person. In some of the
cases which we shall examine later, the tissue had
apparently undergone no degeneration previous to
calcification.

Histological examination of the various concretions and
calculi of the lungs and bronchi shows that they may be
divided into the following classes:--

**Cartilaginous, Bony, Calcareous**

The first two of these are not by any means common
and I shall not deal with them at any great length.

*Cartilaginous* productions may be situated in the
bronchi, pleura, or pulmonary substance. The
cartilages of the trachea or bronchi may be separated
by necrotic changes, as is occasionally seen in tubercle
of these parts, and act like foreign bodies.

*Enchondromata* may form in the lungs, not only in
the bronchial wall but in the pleura, and may become
free and be coughed up.
The parenchymatous tissue of the lungs may undergo various cartilaginous transformations.

A case of multiple enchondroma of the trachea and bronchi is given by Professor Laboulière of Paris. These were present as little calcified nodules projecting from the interior of the air passages. He made sections of these, and states that there is no doubt as to their nature. Andral and Laennec also mention similar cases.

Cartilaginous growths in the costal pleura are more frequent than those of the pulmonary pleura. They may be present as disseminated points, or as small isolated plates separated by healthy tissue; or even a large portion of the surface may be covered by these new growths.

Cruveilhier (Anat.path.général) gives a case in which the right lung was atrophied and covered by a cartilaginous shell.

Virchow (Path.of Tumours) considers that such cases arise most frequently from the proliferation of the sub-endothelial connective tissue which forms a dense sub-pleural fibroma.

Cartilaginous deposits in the lung tissue:— These are found in the substance of the lung tissue, either as little granular masses, or larger irregular-shaped tumours, or as thickened plates interposed between the compressed atrophied lobules.

The majority of these fibro-cartilaginous growths
in the parenchyma appear to arise in seats of tubercular disease. Laennec and Andral give cases in which cavities in the lung have been found containing caseous or cretaceous material, the walls of which were lined with thick, hard, fibro-cartilage.

Sir James Paget had a case of enchondroma of the testicle. This was operated on and removed. The wound healed, and the patient left the hospital. Two months afterwards the patient returned, being very emaciated and short of breath, and soon died. Post Mortem examination showed both lungs full of cartilaginous tubercles, some of which had perforated the branches of the pulmonary artery. Nearly always in the case of cartilaginous broncholiths which are found free in the respiratory passages or expectorated, arise from eroded bronchial cartilages. Portions of these have been separated by the destructive process, and then coughed up.

Osseous deposits in the lungs:— In the same way as cartilaginous growths are found in the various portions of the respiratory tract, so one finds ossification of the bronchial cartilages, of the mucous membrane of the trachea and bronchi, of the pleura and pulmonary parenchyma.

Wilks (Trans. of Path. Soc. London) reported a case of a patient who died of phthisis. In the superficial layers of the mucous membrane of the larynx, trachea, and bronchi, there were found a quantity of
small osseous plates. They were situated in the inter-
cartilaginous spaces, and showed no connection with
the rings of the trachea and bronchi. Sir Morrell
Mackenzie reported a very similar case.

As showing osseous formations in the lung substance
proper, a case is reported by Browning (Trans. Path,
Soc. London) of a woman who died of phthisis, and in
whose left apex was found a cavity the size of an
orange, lined with bone.

Felix Cohn (New York) published a case of diffuse
primary ossification of the lung. Several other cases
are reported by German writers.

The most recent case which I have been able to
find bearing upon this portion of the subject, is one
reported in the Lyon Medical, 1901 by Divée and
Pavyot. A man 64, a cabman, admitted to hospital and
died a few days after. History of chronic alcoholism
and of fracture of ribs some time previously. He was
constantly exposed to all weathers and had great
difficulty in gaining a living. There was a history
of pulmonary haemorrhage 16 years previously.
Examination showed him to be very thin, without the
true cachectic appearance; and there was oedema of
the lower limbs up to the knees. Lips cyanosed;
urine scanty and high-coloured with much albumin and
urates; dyspnoea present. The lungs showed signs of
emphysema and there was diffuse bronchitis. The
pulse was irregular and small. Heart arrhythmic with-
out bruit: apex beat 6th space.
P. M. examination:—Left lung, nothing very important. There was an old cutaneous cicatrix at apex. Right lung, emphysematous at apex. On posterior border, 3 centim. from apex, a hard irregular body was felt. Still lower on the posterior border, there was a little irregular calcareous plate. At the infero-posterior part of the lower lobe there was found a large, hard mass about the size of a big nut. On cutting, it appeared like a sclerous kernel around a large bronchus and a large vessel. There were in it one or two round points greyish, like islands in the sclerous sheet. These were probably caseous. The lymphatic glands though swollen, were not caseous.

This larger portion was examined after decalcification. On being suitably stained it showed itself to be of true bone structure, with bone cells, and Haversian system.

Having briefly looked at the chief varieties and seats of chondrification and ossification of the lungs, we shall next consider the more truly stony products, the pneumoliths, and broncholiths according as they are found in their respective tissues.

Calcification of the pleura:—Numerous examples and varieties of this condition are recorded, the great majority being only found P.M. It is extremely rare for them to be diagnosed during life. I have examined several of the recorded cases, and give in brief the following from the "Bulletin Soc. Anat" of a man who
was under the care of Professor Guyon of Paris.

A man 53, admitted to hospital suffering from haematuria. There appears to have been no symptoms to call attention to his chest. He died about a month after admission. P.M. malignant disease of the right kidney was found. In examining the thorax it was found that the left lung and pleura were healthy, as were the heart and pericardium. The mediastinal glands were healthy. The right lung was adherent to the thoracic wall in most of its length. The pleura was largely composed of a shell of fibro-calcareous tissue, which was easily separated from the lung. Its average thickness was about 3 centimetres. It was most compact and hard towards its centre. On section it was seen to consist of two coats - an external and internal, the space between them being filled with caseous looking material. The external surface of each of these two plates was smooth and like china. Decalcified sections of this showed dense fibrous tissue. There were no traces of tubercle in the lung.

Bacteriological examination of the intervening caseous matter, showed staphyloccoci in great numbers.

The area of the pleural surface which may undergo calcification, may vary, according to the cases recorded, from a piece the size of a sixpence to one covering almost the whole surface. They are generally irregular in shape, and often fibrous towards their outer margins. In connection with pleural calcifications one may men-
tion that occasionally concretions have been found free in the pleural cavity.

Calcification of the Lymphatic Glands of the Lungs and Bronchi:— I have examined the records at Brompton Chest Hospital of about 300 patients on whom P. M. examinations were made, and find the following results in regard to the proportion of those who showed calcareous thoracic glands:—

Bronchial glands - 14' 8 per cent calcareous
Anterior mediastinal - 0' " "
Post " - 0'3' " "
Supra " - 2'6' " "

A large proportion of these cases - about 90 per cent - died directly or indirectly of some tubercular infection. Although a great many of these calcareous glands must have been the result of old tuberculous disease, yet although I have carefully examined the history of a large number of cases (the summary of some of which is given at the end of this work) I have not been able to trace any reliable and consistent relation between calcareous glands and the history of old tubercular disease. Many of the cases were of quite recent origin.

I think it is fair to assume that either calcareous degenerative processes must be more rapidly infected in bronchial and mediastinal glands than in lung tissue, or that it must be as in the case of healed tubercle of lungs, in which are often found traces of calcareous and other forms of healed tubercle, without there having
been any corresponding history of symptoms.

Of all the lymphatic glands those of the mediastinum and mesentery are most liable to be infiltrated with calcareous products. The relation of the bronchial glands is as follows. Taking the bifurcation of the trachea as the starting point, we find a group of glands between the right and left bronchus. They are from 10 to 15 in number, and vary in size from that of a small pea to that of an almond. The glands towards the right bronchus are larger than those towards the left. Glands are also situated upon the tubes; they are few in number and small. The vascular supply of the glands, which is free, is derived from the bronchial arteries, and the blood is returned to the bronchial veins. Afferent lymphatics reach the glands from the lungs, from the pleura, from the neck and other neighbouring parts. Besides these groups of comparatively large glands, numerous minute lymphatic glands are found in connection with the primary divisions of the bronchi; chiefly at the back of these tubes, and even down to the second and tertiary divisions of the bronchi.

The central group of glands is in relation in front with the pericardium, the arch of the aorta and the pulmonary artery; behind with the pulmonary plexus of nerves, the aosophagus, the aorta, and the vena azygos, etc.

The ganglia on the upper anterior and posterior surfaces of the right bronchus are four or five in
number, and smaller than those of the central group. Their situation brings them into relation with the arch of the aorta, the innominata and subclavian arteries. The ganglia on the left bronchus are still smaller than those of the right side. Their position gives them relation with the arch of the aorta, the origin of the left carotid and subclavian arteries, the left branch of the pulmonary artery, with the large veins, with the left pneumogastric nerve, and especially with its recurrent branch.

We are only here interested in the glands which are found in direct relation either to the bronchi or the pulmonary tissue; these glands alone when they are degenerated, being susceptible of communicating with the bronchi, and of there insinuating their caseous or calcareous products. Frequently these calcareous lymphatic productions exist in old age in those in whose osseous system some alteration exists, which has caused a notable absorption of lime salts.

In the case of metastatic calcareous lymphatic glands, there is not often concomitant pulmonary tuberculosis.

Calcified bronchial glands may be of two different kinds.

(a) As a cretaceous mass more or less dense resembling moulded plaster, and easily crushed between the fingers. They may be white in colour or have an appearance like putty. These cretaceous products - "concrétion cretacée," of Laennec - may be the size of
a pin's head, or occupy the whole mass of the gland, which in certain cases may be very enlarged.

(b) Sometimes they are stony concretions and have the smoothness and hardness of a pebble. Among these concretions, which may be solitary or agglomerated in the same gland, some are round, others irregular, while others present faceted surfaces and seem to result from the approximation of several calcareous nodules.

Macroscopic appearance: Most frequently these concretions, on section, show a central hard part, and around this a layer of cretaceous material, soft and of caseous appearance. There are the two different stages of calcareous infiltration which occur in the drying up process, and which when further continued, give rise to a hard calculus.

At other times, but much more rarely, the contrary disposition may be seen; the centre of the concretion being of the consistence of putty, while the periphery has the hardness of a stone, as in the case reported by Du Castel. The glands thus impregnated with lime salts are of various sizes from that of a lentil to a large nut or a hen's egg. They are generally surrounded by dense connective tissue, which makes them adherent to the adjacent tissues. This surrounding layer of connective tissue may become very resistant, and form a kind of sheath which may itself become infiltrated with lime salts.
Migration of these concretions:— We may now endeavour to see how they may become free, and how they may be expectorated.

In consequence of the intimate relation which these glands bear to the large bronchi and the large vessels, these stony products may, by their size or by their accumulation, deform or compress the air passages. That however is not the principal danger. The chief danger is from their movement, for in spite of the surrounding necrosed tissue, these concretions may, either by contact or by inflammatory processes, penetrate the neighbouring tissues. They have been known to perforate the bronchial tubes, and becoming free in the respiratory passages, may be expectorated as broncholiths. Much more rarely have they been known to perforate the wall of a neighbouring blood vessel, but such a contingency may occur. Dr. Percy Kidd (in Path. Trans) records two remarkable cases, in one of which death was caused by the impaction of a caseous gland in the trachea; the other in which death resulted from profuse haemorrhage caused by ulceration perforating the pulmonary artery, due to the pressure of a calcareous gland.

Reillet and Barthez (Maladies des Enfants) mention a case in which they were able to trace the phases of perforation of the bronchus by a calcified tubercular gland, about the size of a pea.

Cruveilhier (p 361) also states that he has seen
P.M. the communication between the bronchi and calcareous glands.

L. Shaw (Path Soc Trans. London) reports a case of localised bronchiectasis caused by the invasion into the bronchus of a caseating bronchial gland.

Many writers regard calcified bronchial glands as the most common mode of origin of the concretions found free in the respiratory passages.

In speaking on this subject to Dr. Kingston Fowler—the joint author with Dr. Godlee of the well-known book on Diseases of the Lungs—he informed me that when he first tried Koch's tuberculin, several of his patients brought up these broncholiths. It had evidently set up a fresh inflammation around these nodules, and they had eroded their way out. Thus, he said, showing the danger of using the tuberculin, and probably starting a fresh infection.

**Histologically:**—These calcified glands are most frequently true concretions without organic framework. In rare cases however these may be a structureless homogeneous framework of organic material. On microscopic section, they show a homogeneous aspect more or less granular. The histological examination of the surrounding tissues always shows some neoformative connective tissue, more or less dense, and of varying quantity. This surrounding tissue is generally permeated by inhaled carbonaceous particles which give them a greyish or blackish aspect.
Bacteriologically:— We have seen that some of these are of non-tuberculous origin, but many undoubtedly are. The question of what becomes of the tubercle bacilli and of their infectivity will be considered in conjunction with other concretions at a later stage of this paper.

Chemically:— These are the same as the pulmonary calculi; that is to say carbonate and phosphate of lime with traces of magnesia and fatty matter, and often matter which has come from without, such as dust particles, stony particles, etc.

**PARENCHYMATOUS CONCRETIONS**

The pulmonary parenchyma may become infiltrated with calcareous salts, giving rise to three varieties of lung stones:—

(A) The lung tissue may become calcified without any apparent previous change, and after decalcification each class of fibre may be recovered without any change from its normal structure.

(B) In the second class there is a previous lesion; the tissues in a more or less attenuated state undergo consecutive alteration which may be due to a mechanical or bacillary inflammation. Calcification may take place in such tissues at any stage of their necrosis, and thus give rise to different appearances. The pulmonary lesion which is by far the most common, cause of this condition, is of course tubercle.
Another class comprises the cysts and tumours found in the lungs.

Class "A" in which the lung tissue may become incrusted with calcareous salts without having previously undergone any apparent histological change.

This statement is based on the observation of Virchow. Among the seven cases cited by him in support of his theory of calcareous metastasis, five relate to calcareous deposits in the lungs.

The following extract is taken from one of his cases which is perhaps the most typical.

A woman aged 27 was brought to hospital suffering from gastric ulcer, from which she died. She had no history of cough or haemoptysis. At the P.M. examination, the right lung in the upper lobe seemed to be in a state of semi inspiration, and to occupy a larger volume than usual. It was not easily depressed. On cutting with a knife there was a crepitating sensation. Microscopical examination of the denser parts showed a calcification of the alveolar walls. Portions were submitted to decalcification for 24 hours, and these on being microscopically examined, showed no difference in the lung structure from the portions of lung tissue which were not calcified, and which were cut, mounted, and stained in the same way.

At the edges of the portions in which the lime salts were deposited, one could see the calcification in its different stages. They were either like scattered chalky granulations, or like closer collections
following the fibres of the tissue. These sometimes formed thin projections of calcification which, further on, were mixed with bands of closer petrified material. The alveolar cavities of the calcified parts were permeable to air. There was some slight pneumatic exudation at the base of the lung. The pulmonary epithelium was not altered. The larger vessels were patent.

Virchow says that in the case of metastatic calcification of the lungs, when there are no pulmonary lesions, petrefaction occurs to a great extent without diminishing the permeability of the respiratory organs. They resemble a fine sponge. He also says, "After dissolving away the calcareous matter, the original structural proportion is reproduced, and one is not able to distinguish any alteration in the organic base. The question then is of a direct calcification of the tissue, in which the earthy salts penetrate and fill up the parts in a manner similar to that which occurs in muscles, nerves, and fibres of the crystalline lens."

In class "B", that is when there is previous alteration of the lung tissue, we include such changes as - infarcts, chronic broncho-pneumonic patches, miliary abscesses, gummatas, and tubercular concretions.

Infarcts may undergo fibrous cicatrisation in which calcareous degeneration may take place. Talmann believes that this process is common in old people, and that many of the calcareous nodules found in their lungs are of this origin.
Broncho-pneumonic patches giving rise to small pulmonary abscesses may become surrounded by a zone of connective tissue, which first isolates them and prevents them from spreading into the neighbouring tissue of bronchioles. Under these conditions they may rapidly undergo a kind of condensation, when the pus becomes thick and susceptible of being penetrated by calcareous salts. Foerstner and Hüter (Deutsche Klinik) have recorded examples of the above condition.

Before passing on to consider true tuberculous calcification, one may mention a case of pseudo tuberculous calcification of the parenchyma.

At the congress of medicine held in Vienna in 1890 Eppingen recorded a case of calcareous deposit in the lungs due to calcification of a cladothrix. It resembled tubercular calcification, and the true nature was only discovered by bacteriological examination.

Calcification of true tubercular deposits: The presence of calcareous deposits in the lungs of persons who have died of pulmonary tuberculosis, is quite commonly seen in the post-mortem room.

Obsolete tubercle in various forms is met with in the lungs of those who were previously not known to be phthisical, in proportions as given by various authors of from 4.7 to 7.5 per cent. (Heitler, Osler)

As regards purely calcareous deposits in the lungs of persons not previously known to be tuberculous, I am unable to find any record. But in tubercular
patients in whose lungs calcareous deposits were found. P. M. the proportions given by Reillet and Barthez is 8 per cent. I have examined the post-mortem records of 200 patients in the Brompton Hospital who died of pulmonary tuberculosis, and find that the proportion of those who had calcareous deposits in the lungs, was 9 per cent. These deposits were either pneumoliths — i.e. calcareous bodies lying free in cavities — or ordinary deposits in the lung substance, adherent to the adjacent membrane. Details of some of these cases are given at the end of this paper.

These chalky masses are found disseminated in the lungs, but it is much more frequent to find them at the apices of the superior lobes.

Among the different transformations which may take place in ordinary cases of pulmonary tubercular lesions, the one most favourable to the patient is that which limits and isolates the lesion, by the penetration of calcareous particles. We know that tubercular material encased in a fibrous sheath possesses active and toxic bacilli, but, as we shall see later, it is rare to find tubercle bacilli in the harder calculi or concretions of the lungs at all, and inoculation experiments (so far as I have been able to find out) have yielded negative results.

The formation of these deposits appears to be a gradual one. In the first stage calcareous particles which are precipitated, replace, grain by grain, the caseous particles. When this has only partially
progressed, we find those soft and damp concretions, like putty. When the deposition is complete we have a hard and chalky deposit.

**Duration:** It is very difficult to determine the exact commencement of the lesion, and the duration of the change. The symptoms have not usually been sufficiently severe to attract the attention of the patient. Even in cases where the onset of disease was observed, one could not say definitely how long calcification was accomplished.

Neuwerck (Deutsche med. Wochenschrft) cites a case in which tubercle had shown itself six years previously. Andral mentions the case of a woman who died of cancer of the stomach. She had a history of tuberculosis "several years previously." In the apices of both right and left lungs there were cretaceus nodules of the consistence of putty.

**External appearances:** Tubercular concretions have two perfectly distinct aspects. One class resemble chalk, more or less damp, generally white, sometimes yellow. The other is usually like a small stone, very hard and irregular, and presenting numerous pits, but having in general a rounded form. It does not present the branching processes, as bronchial concretions do. The colour is white or yellow.

These two forms may be met together or separately. In the former case the stony mass is found in the centre of the softer mass, and the whole surrounded by
a fibrous coat more or less thick. The size also is very variable, generally small, about the size of a millet seed, but they may be found as large as a pea, a marble, or even a pigeon's egg.

The number too is equally variable, mostly one, two or three, at other times the lung seems to be riddled with them.

**Internal structure:** The harder chalky formation are always most dense in the centre. This was the first to calcify, and it became augmented by layers of subsequent calcification. The softer tubercular concretions have no apparent fibrous substratum, and are amorphous in appearance.

**Site:** Tubercular concretions are met with most often at the apices, generally both apices, but when unilateral, most frequently at the right. Generally they are situated in the interior of the lung substance, sometimes they are seen under the pleura, and then there is a kind of cicatricial depression of the pleura.

**Surrounding tissue:** Often the pulmonary tissue seems perfectly healthy, but microscopically there is always seen in smaller or larger quantity, a connective tissue proliferation; an interstitial pneumonia which fixes the concretion. More commonly there is an envelope or pocket of connective tissue more or less dense and thick, according as the contents are more or less chalky.

**Microscopical examination:** Of these concretions which have been previously treated with a diluted solution of
hydrochloric acid may show a granular residue without definite structure. At other times elastic fibres are seen, fragments of alveolar walls, or even a kind of skeleton of lobules which were involved in the calcification before their destruction was complete. Crystals of cholesterin are also found sometimes, in addition to the calcareous granules. These are in the usual rhomboid masses. Black pigment too is found, which comes from inhaled particles.

The most recent cases published — three by Professor Stern, Sept. 1904 — agree with the above conclusions compiled from observations of other authors. After decalcification with nitric acid, "There remained a framework of organic material which retained the original shape of the stone." These were cut into sections after hardening in alcohol and embedding in paraffin. In one case out of the three, badly stained nuclei could be demonstrated. In the other two cases there was no trace of tissue, only a structureless homogeneous mass. In two of the three cases which came under my own notice, I also found on decalcification, an organic framework. The bacteriological examination of one of these is given at a later stage.

Bacteriological examination of pulmonary concretions:

The presence of tubercle bacilli in the lesions is the proof of their tubercular nature. But it does not necessarily follow that because one cannot find these bacilli, one can reject the diagnosis of tubercle.
Dejerine in his "Recherches des bacilles dans la tuberculose calcifiée," has gone carefully into this subject. The calcified masses, washed and soaked in sterilised distilled water, were crushed in a mortar. The resulting liquid resembled milk of lime, and small fragments of organic substance were found in the liquid. These fragments were the remains of pre-existing pulmonary parenchyma, and presented in places distinct traces of pulmonary alveoli with thickened walls. Various specimens were examined after being stained in the ordinary way.

Dejerine made researches in 17 cases of calcareous concretions found in the apices of the lungs of people having no other tuberculous manifestations. The following are his conclusions relative to the presence of tubercle bacilli in these concretions.

1. In ten cases of the densely stony concretions, in spite of the minutest examination, it was impossible to detect the presence of a single tubercle bacillus. In one case only did some bacilli seem to exist. They were situated on a calcified fragment of pulmonary tissue, and were covered by a thin fossilised plate, and were themselves, it seemed, in a calcareous condition.

2. In seven cases of the softer concretion the bacilli were absent in the harder parts. There were however bacilli present in these 7 cases in the softer pulpy portion of the calcification.

Professor Stern submitted his three cases to bacteriological examination also. In two of them neither
tubercle bacilli nor other organisms were found; in the third, a few acid fast bacilli, having the characteristic size and shape of tubercle bacilli, were found, so that the tuberculous origin of the disease was rendered practically certain. In my own cases no tubercle bacilli were found, but in one case there were some streptococci and stapylococci.

Déjerine says, "Generally speaking, the bacilli disappeared as the calcification became more dense or hard. They seemed to be encased in the calcareous mass, first fossilised and then entirely calcified and transformed."

Inoculation:— As regards the virulence of these products, Déjerine obtained the following results:—

(1) Inoculation practised on guinea-pigs with the liquid obtained by crushing the harder calcified nodules in sterilised water, gave no results. P.M. examination showed no trace of tubercle in the inoculated animals.

(2) Experiments with the softer concretion also gave negative results, but Déjerine seems to be a little doubtful about some of these latter.

Chemically:— These concretions have been chemically examined by various writers, and all agree that they are chiefly composed of phosphate of lime with a little phosphate or carbonate of magnesia, and carbonate of calcium, together with a little organic matter.

Destination and Evolution of these concretions:— The cases which are given in the following pages will show what becomes of some of them.
We may sum up by saying that what has been remarked on glandular concretions is equally applicable to pulmonary. They may remain latent during life without causing any inconvenience or inflammatory reaction, but under the influence of other pulmonary lesions, or of neighbouring tuberculosis disease of a progressive nature, these concretions may become free in some cavity, and make their way from these into the bronchial tubes; or they may penetrate a neighbouring bronchial wall and then become eliminated. By one of these processes parenchymatous broncholiths may be expectorated. The following are a résumé of a few of the cases which I have met with in going into this subject of concretion of the lungs:—

Case I. reported by Dr. Theodore Fisher, Physician and Pathologist to Bristol Informary, (1901)

A woman aged 32, unmarried, admitted with pneumonia, and died the same day. P.M. examination. Body well nourished, average height. Both lungs were adherent to the chest wall. The apices were pigmented and scarred from presence of local superficial tuberculosis disease, but no fibroid or calcareous nodules were present in the thickened patches, and no old tubercular nodules were present over the pleurae. The right lung was consolidated throughout. The left lung showed no recent consolidation, but was abnormally resistant. Both cut with difficulty. The cut surfaces yielded a strange sensation. Everywhere very gritty, and small granular
like grains of sand were left on the fingers. The substance of the lung from apex to base was studded with these granules. The left lung, although almost free from disease, sank in water on account of the granules in it. The bronchial and mediastinal glands showed no apparent change. On drying, the granules lost their sand-like appearance, and became shrivelled and lustreless.

Examination showed them to be round, transparent or translucent nodules, hard, and of uniform size. Microscopically they appeared to be built up of concentric laminae, and the surfaces of many of them showed markings corresponding in size and shape to the outline of the pulmonary alveoli. On prolonged ignition, they left about 76% of ash which was nearly all phosphate of lime, with a little carbonate. On decalcification with hydrochloric acid, a concentric lamina of organic matter was visible. Portions of the lung free from pneumonia, showed very little change. There was no evidence of chronic disease. The nodules generally lay in the walls of the alveoli, which were of normal thickness; but here and there localised fibroid thickening in the immediate neighbourhood of a nodule was seen.

Lamination of the nodules was distinct, and traceable to the centre. The vessels were everywhere healthy.

Dr. Ophüls in a recent article, discusses the formation of such bodies, and considers them to be produced by the deposit of anyloid matter around a nucleus.
of degenerating cells.
In the Bulletin de la Société Anatomique, 1896, p 869 I came across the following case, which seems to supply the intermediate stage of degeneration of the above case of Dr. Fisher. It is a case of corpora amylacea of the lung. A patient died of typhoid fever. Sections of the lungs showed the presence of remarkable corpuscles resembling grains of potato starch. Like these, they presented a central portion around which were disposed concentric layers. He concludes, "They are very probably formed of albumenoid products of cellular degeneration."

Case II. by Professor Stern:-- A girl aged 17, of robust appearance, but with a history of pulmonary disease on the mother's side, had had attacks of haemoptysis for several years, when in May, 1904, she consulted the writer. Five years previously she had influenza which was followed by a subacute form of inflammation of the lungs. Pyrexia continued for 3 months, and the sputum was occasionally blood-tinged. No tubercle bacilli were found. She apparently recovered, but 4 months later, slight haemoptysis occurred. In the autumn of 1902 there were more serious attacks of haemoptysis: sometimes nearly a pint of bright red, frothy blood being expectorated at once. About the same time, and on several subsequent occasions, small calculi or concretions, about 3 of an inch in their greatest diameter, were coughed up. There were slight dulness and
deficient pulmonary expansion at the right base posteriorly, and impaired resonance in the right supra-clavicular fossa without auscultatory signs. At the same time there was neither cough nor expectoration. The remaining organs were healthy. The calculi were hard, of yellowish colour, and had irregular and jagged surfaces.

Bacteriological examination showed that they contained "a few acid-resisting bacilli, having the size and shape of tubercle bacilli; so that the tuberculous origin of the disease was rendered practically certain."

Case III. (from Bulletin Soc. Anat. 1901) A calcified plate in the lung:— A woman from whom no clinical history was available, since she was moribund when admitted to the hospital, presented signs of advanced tuberculosis of both apices. She died two days after admission. At the P.M. after examining the diseased condition of the apices, we were astonished, on cutting the left lung, to feel a stony body in the inferior lobe. On opening up the parenchyma there was found embedded a hard plate. It was slightly nodulated, and had the appearance of an oyster shell. It measured 6 centimetres in length, and 5 across. It was oval in shape, and had two surfaces— one convex and one ribbed. The concave surface was smooth at the margin, but its central part was covered by a kind of membrane. The edges were irregular, and had a number of projections which were for the most part engaged in the bronchial
orifices, some of them so thoroughly that it was necessary to break them in order to extract it.

This stony concretion was situated in the midst of the pulmonary parenchyma at the base of the left inferior lobe, but in the centre of a kind of fibrosis sheath. There was a kind of cavity in which the bronchial ramifications opened. The orifices of these bronchial tubes varied from $\frac{1}{2}$ to 1 millimetre in diameter, and were partly filled with a fluid exudate. The remainder of the inferior lobe was the seat of an intense fibrous sclerosis, and of large white fibrous bands. Microscopical examination showed it to be composed of layers of old fibrous tissue which had become calcified.

The author of this paper concludes:—"In the absence of clinical history, we can only make a hypothesis as to its origin. We consider that it must be regarded as a remnant of an old pulmonary affection - an abscess, or a focus of caseous pneumonia. The state of the surrounding parts showed that the inflammatory lesion had persisted for a long time."

Case IV. The two following cases came under my own notice, being admitted suffering from bronchiectasis:—An electric car driver, aged 27 unmarried. He had a history of pneumonia (left side) at 14. At 15 a doubtful history of being in hospital for phthisis. A definite history of rheumatic fever at 17. He had a cough and copious expectoration for last two years, and had a considerable haemoptysis 18 months ago, and a slight one a week before admission.
The patient was thin, poorly nourished, but not anaemic. Temperature, pulse, and respiration normal. Numerous tubercle bacilli found in sputum. He had marked clubbing of the fingers, and curving of the nails. Breath very offensive. His chest was thin and barrel-shaped. The heart sounds were weak, but there were no murmurs. The breath sounds at both apices were harsh, and the expiration prolonged. There were a few crackling râles. Posteriorly on the right side, the breath sounds were harsh with prolonged expiration. There were some râles and fine râles. The patient was expectorating about 12 ozs of purulent greenish-yellow viscid sputum in the 24 hours. Its odour was very offensive. About a fortnight after admission, in a fit of coughing, he brought up a small calculus. On being asked about this, he stated that he had frequently, during the previous five years, brought up similar calculi, most of them being about the size of a pea. The one which he expectorated in the hospital was a whitish-grey colour, very hard, about 4 inch long, and 3 broad, irregular in shape, and with ragged edges. Chemically it consisted of calcium phosphate and carbonate.

Although this patient remained in the hospital some six weeks after this, he never expectorated any more of these calculi, nor was there any more haemoptysis.

Case V. A woman aged 25, unmarried, no family history of consumption. There was however a history of her having had a stone in the bladder at the age of
9 which shows that she had a calcareous diathesis. She had pneumonia at the age of 10. Her present illness dated from 14 months previously. She had cough, night sweats, and wasting. There were tubercle bacilli in the sputum. She had had slight haemoptysis on two occasions about a month before admission. Both apices were involved in active disease. Twice during her stay in hospital she expectorated small calculi, both hard, chalky, and irregular, about the size of a pea. On decalcification, neither contained tubercle bacilli, but both showed yellow, elastic fibres, inspissated pus cells, numerous streptococci, and a few pneumococci.

Case VI. Poulalion gives a remarkable case very fully of which the following is a résumé:— A man aged 40 came to the hospital complaining of a severe cough with which he was constantly bringing up small concretions. He brought a large number of these in a bottle with him. As he said himself, "I am always coughing up stones like small pieces of bone; there must be a regular stone quarry in my chest."

He had twice had pneumonia and once bronchitis. He used to have attacks of coughing sometimes lasting two hours, and at the end a stone would be expectorated, when the cough ceased. He generally coughed up a calculus every day or two. Blood was always found in the sputum, with the calculi. No tubercle bacilli were found, although frequently looked for. The patient improved, but returned to hospital about a year later. This time numerous râles were heard in the left chest.
He had fever and loss of appetite, and calculi were expectorated as before. He died soon after, and on P.M. examination a chronic pneumonia was found on both sides, the left pleura adherent in its greater part. In both lungs were found concretions in small, hollow spaces in the tissue. Some were in the lung substance itself, and their connection with the bronchi was not evident. Others were found in small cavities which opened directly into enlarged bronchi.

Numerous other cases of calcification of parenchymatous tissue are recorded, but perhaps to complete this portion of the subject it is only necessary to mention that among the rarer forms are small, encysted pleurisies, hydatized cysts, dermoid cysts, and chondromata which may undergo calcification.

**CONCRETIONS FOUND IN THE BRONCHIAL TUBES**

There still remains another important class of broncholiths apart from those which are formed from calcified glands, and from pulmonary parenchyma, namely, those which are formed in the bronchi or in cavities connected with them, as, bronchiectatic cavities.

I do not propose to consider under the head of broncholiths those which arise from inspired foreign bodies. These, if they remain for some time in the air passages, may undergo calcification. In Notnagel's encyclopaedia, the volume which treats of diseases of the lungs and bronchi, a very complete list is given of the foreign bodies found in the air passages. In a
list of 148 cases, one is mentioned as a lung stone of internal origin. Here I only propose to consider those which have an internal origin. Most writers agree that blood clots, portions of membrane, the retained contents of bronchiectatic cavities, or even sputum which may have become stagnant in certain places, are all liable to undergo calcification, and so form a hard stone. It is probable that bacteriological agencies aided by a constitutional anomaly, play an important part in this formation. They are comparable to urinary and biliary calculi. From the reports of various observers, (Laennec, Widal, etc) it appears certain that the calcareous products are formed in the bronchi even when the lungs and glands do not show any tuberculous change, or any other concretions of another nature. The following cases are given from a considerable number recorded on this portion of the subject:—

Hamilton (Dub. Hosp. Gazette) called to see a lady aged 22, suffering from dyspnoea, severe cough, and had brought up several ounces of pure blood. At intervals she had a return of the haemoptysis, cough, and dyspnoea and during an attack she brought up a calculus. Two days later she expectorated a smaller calculus, and again three days after that, a third. The first of these is described as like a piece of finely divided corral, and formed a mould of the smaller bronchial tubes. From its size it would have been deemed impossible that it could have come through the rima glottidis. The second one expectorated was quite small,
while the third "at first view looked like corral or a bunch of grapes." It is no doubt a perfect cast of the minuter bronchial tubes." This patient subsequently (18 months after) developed consumption, though up to the time of expectorating these concretions she had had no symptoms of it.

The following two cases are both from the American Journal of Medical Science, 1901."

Case II. A woman aged 43, developed pleurisy with effusion on the left side, from which she subsequently died. At the autopsy, the left pleural cavity was filled with purulent exudation. A concretion was found in a dilated bronchus which communicated with the pleural cavity by a fistulous tract. Both lungs were otherwise healthy.

Case III. A man had spitting of blood and signs of pneumonia on the left side. At the P.M. examination no signs of tubercle were found. The bronchi were dilated, and one of them contained a small, chalky mass which was branched. Around it the lung tissue was pneumonic. The mucous membrane of the tube was ulcerated, but not perforated.

Case IV. Reported by Dalma (from Notthagal's Encyclopaedia) A stone had almost entirely occluded the bronchus leading to the lower lobe of the right lung. To the distal side of the broncholith the bronchi were enlarged, and inflamed, and filled with pus. Several opened into the pleural cavity, and gave rise to emphysema.
Case V. Mager records the history of a woman aged 28 who had had pneumonia in early childhood. Shortly before the time reported, she had paroxysmal attacks of coughing, and often expectorated lung stones, which varied in size from 0.5 to 1 centimetre, and were composed of magnesium and calcium phosphate. "This case seemed to be one of primary broncholithiasis, since it was preceded by no recent disease, excepting slight bronchitis."

Case VI. This was a case of one of my own patients. He had a history of a cough etc, for five months. There were well-marked symptoms of pulmonary tuberculosis at both apices, and tubercle bacilli in large numbers were found in the sputum. His larynx was also affected. During an ordinary fit of coughing he brought up a small calculus, which was about 1/3 of an inch long, and about 1/3 of an inch broad. At one extremity it was divided into two small branching processes. It was white and extremely hard, and its surface was rough and irregular. It came up without any difficulty, and was unaccompanied by any pain or haemoptysis. Chemically it consisted of phosphate of lime and some carbonate. As this was the first case of a broncholith which I had seen, it never occurred to me to make a bacteriological examination of the product, and although I kept in communication with the patient for some months, after he left hospital, he never again expectorated any more of these concretions. He made most satisfactory
progress, and was able to return to work in a few months. After going through the above, and many other cases, one comes to these conclusions regarding broncholiths.

They may form in the larger bronchi or smaller bronchioles. Their number is usually restricted, generally one, sometimes two or three. After their expulsion, healing is the rule. (I admit that most of the cases which I have given do not support this statement, but they were chosen partly on account of the P.M. confirmation.) They may take the form of the cavity in which they are developed, and thus be more or less irregular. They may have a granular surface like a raspberry, or have sharp projections. In size they are mostly small, varying from a grain of hempseed to a pea or a marble. Their colour is white or greyish-white. Sometimes the texture is uniform, at other times it shows concentric stratification. This stratified condition is chiefly found in calculi formed around foreign bodies.

Chemically broncholiths appear to have the same composition as the other concretions which we have considered, namely, phosphate of lime, carbonate of lime, with traces of carbonate of magnesia and organic matter.

Pathology. Laennec thought that they were due to inhaled dust, and Morgagni "to a too thick humour long retained in the pulmonary cells."

We may consider that bronchial calculi may be
secondary to the pathological secretion of mucus, due to the presence of some bronchial lesion, or to fibrinous exudation or blood clots. If any of these products remain adherent to the bronchial wall, and mucus accumulates around them, they may rapidly undergo calcification, probably by bacteriological agencies.

Symptoms:— Although in the majority of cases broncholiths are expectorated without giving any trouble, yet they may produce symptoms:—

(1) From movement in the normal air passages giving rise to "Stone asthma."

(2) From local irritation and inflammation giving rise to symptoms of localised bronchitis or broncho-pneumonia, fibrous pneumonia, or even abscess.

(3) Bronchiectasis, from the blocking of the bronchial tube, and the impairment by inflammatory degeneration of the normal resiliency of the bronchioles.

Clinical Considerations:— In order to enable us to more fully consider the subject of concretions and calculi of the lungs and bronchi from the clinical aspect, it may be as well to give a few cases from which general deductions may be drawn, in addition to those already mentioned. The following are condensed from various sources:—

(1) Widal gives the case of a man who had moist sounds in his left chest, with prolonged expiration: he also had haemoptysis. On P.M. examination there was found a branching calcareous mass, in a dilated bronchus.
He had been thought to be a case of pulmonary tuberculosis, but no tubercle was found in the pulmonary parenchyma.

(2) Carlyon gives following case:- Suddenly called to see a woman aged 35 who for years had suffered from phthisis. She had had no active signs recently. She had been seized with a violent fit of coughing whilst out walking. The breathing was laboured, there was much wheezing like an asthmatic attack. On auscultation, there were a few râles - a new feature - with inspiration and expiration, and not affected by coughing. Symptoms continued till next day when, in a fit of coughing, the patient brought up a calculus which she thought was a piece of bone. It was an elongated calculus weighing 3 grains. The symptoms entirely disappeared after this.

(3) A fireman in Navy sent to hospital as a case of bronchitis. Physical examination almost negative. A few harsh râles in 2nd left interspace: temperature 101: pulse 84: Respiration 24. He had sharp pain increased by cough referred to in the above-mentioned spot. Cough was frequent, and occasionally some thin yellowish sputum brought up. He continued in much the same condition for several days, the pain remaining, and a patch of dulness, about 3 inches in diameter, was found over the painful area.

The temperature was of hectic type. No tubercle bacilli could be found in the sputum. Fourteen days
after admission, in a violent fit of coughing, he brought up a concretion $\frac{3}{4}$ of an inch long, and $\frac{1}{4}$ in diameter. It was conical in shape and had rough, jagged edges. There was no previous history of any illness or of the inhaling of any foreign body. The man made a rapid recovery.

(4) A medical man in active practice began to have a cough, hectic fever, and occasional haemoptysis, and loss of weight. There were moist sounds and dulness under the right clavicle. He gradually got worse, until one day, in a fit of coughing, he expectorated two small concretions of the size of millet seed. He steadily improved after this.

(5) A man aged 53 was seen during the summer of 1903. There was a history of his having had a cough the year previously, for some months, accompanied by repeated haemoptysis. In the spring of 1903 he was confined to bed with cough and pyrexia. There were no abnormal physical signs, and no satisfactory diagnosis was made. The sputum contained blood, but no tubercle bacilli were found, although repeatedly looked for. An X Ray examination was negative. On three occasions in Sept 1903, several concretions were expectorated. Haemoptysis then ceased for several months, but in the spring of 1904 it recurred slightly. The general condition was good, and the patient was gaining weight. At the end of June 1904, there was neither cough nor expectoration. The physical signs remained negative.
The concretions expectorated were quite small, not much larger than a pin's head, hard, yellowish-white in colour, and of the usual chemical composition. No tubercle bacilli were found in them.

Numerous other cases very similar to the above might be quoted. They have been reported at various times in the medical journals, as I found in the course of this study of nearly every country, English, French, German, American, Italian, Spanish, and Japanese. There is one condition which one must refer to in considering this subject from a clinical standpoint, and one which is brought out prominently in the five cases just given. That is that if pulmonary tuberculosis be not present, pulmonary calculi may give rise to symptoms closely resembling those of phthisis; that is the old pseudo-phthisis calculosa. Much attention was given, and much was written on this subject many years ago. That it is still present with us, and may give rise to apparently well-marked clinical symptoms of pulmonary tuberculosis the four cases recently published in the Deutsche Med. Woch. by Professor Stern show clearly.

It very frequently happens however, that a calculus in the lung or a bronchus may, like a gall-or a renal stone, give rise to no clinical symptoms at all during life, and it is only at an autopsy that their presence is revealed. If the stone be firmly fixed, and is aseptic, and no infection arises from without, then
there is no reason why symptoms should be present. But if any of these conditions be wanting, then either an acute or chronic disturbance arises. The acute condition has been termed Stone Asthma (Osler, etc.) of which the following are the chief symptoms:

There may be pain, frequently retrosternal. The patient has a sense of heaviness in the chest: there may be an acute burning sensation in the lower part of the trachea: cough comes on resembling an attack of whooping cough, and like it may cause intense dyspnoea. Haemoptysis may accompany the expectoration, and there may be a rise in temperature. Suddenly, and generally with an extra burst of coughing, the calculus is expectorated, and almost immediate relief is obtained. It may happen however, that the stone is not coughed up at once, and then there are repeated attacks of coughing until it is removed.

Some of these cases assume a chronic form. The patient is a prey to severe respiratory troubles. He coughs, spits up an abundant purulent sputum, becomes thin and feeble. There is fever and congestion of the surrounding tissue, with moist sounds. This is the pseudophthisis calculosa which has already been mentioned.

These cases must be extremely difficult to distinguish from ordinary pulmonary tuberculosis, unless one adheres strictly to the necessity of finding tubercle bacilli in the sputum. In these cases it may happen that a portion of the concretion is coughed
up, and this, together with the absence of tubercle bacilli, will effect a diagnosis. The Röntgen Rays have been used as a diagnostic agent, but so far as I have been able to ascertain, without result; probably owing to the usual smallness of these bodies, or to the fact that it would be impossible to distinguish them from calcified pulmonary tissue, or calcified lymphatic glands.

**DIAGNOSIS & PROGNOSIS.**

From what has already been said, it will be seen that when a calculus or portion of one has not been expectorated, the diagnosis is by no means easy. If a patient had previously expectorated a calculus, in any subsequent attacks their presence may be suspected. In the event of a concretion or calculus being expectorated, microscopical examination will tell if it be osseous, cartilaginous, or calcareous.

We may summarise the symptoms which would aid in a diagnosis as follows:—

(1) Expulsion of a stone or a portion of a stone.
(2) Blood with the sputum, usually slight, may be severe.
(3) Pain, usually indefinite in character, not easy to locate, often only a feeling of pressure on the chest.
(4) Cough only occurs during the attack, and is of a violent, convulsive character.
(5) Dyspnoea with characteristic severity during an attack.
(6) Fever due to inflammatory processes which may develop after the formation of the stone, or may be entirely absent.
The three patients who came under my own notice had no premonitory symptoms, and the expectoration of the calculus caused no trouble. As they were all known to have had phthisis previously, one cannot attribute any previous symptoms of haemoptysis, etc, to them.

Prognosis:— In the case of a broncholith, the prognosis is good, provided the patient is able to expectorate the calculus. If however, a calculus remain in the bronchial passages or lung substance, and is not firmly fixed, it may erode the adjacent surfaces, and leave a suitable soil for any infective organism, and may thus give rise, as we have seen, to bronchiectasis, abscess, pneumothorax, pyo-pneumothorax, etc, according to its position.

Treatment:— It is scarcely possible to consider surgical interference, and so the treatment of this condition must be summed up in the word "symptomatic."

The annexed table is compiled from the post mortem records of cases which died in Brompton Chest Hospital. I have referred to this table in one or two places, and some of the percentages given are based on the consideration of these and many other similar cases.
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<th>Patient</th>
<th>Cause of Death</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. 82</td>
<td>Pneumothorax</td>
<td>Tuberculosis of lung filled with pus.</td>
</tr>
<tr>
<td>E. L. 19</td>
<td>Chronic Pulmonary Tuberculosis</td>
<td>Tubercular ulcer of intestine.</td>
</tr>
<tr>
<td>14- P. 36</td>
<td>Chronic Pulmonary Tuberculosis</td>
<td>Admitted with Pneumothorax, was present on admission.</td>
</tr>
<tr>
<td>Name</td>
<td>Occupation</td>
<td>Glands affected</td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
<td>----------------</td>
</tr>
<tr>
<td>M. S. 25</td>
<td>servant</td>
<td>mostly bronchiolar glands, natural; but one is congested in right lung</td>
</tr>
<tr>
<td>W. J. of Schoolboy</td>
<td></td>
<td>bronchiolar glands, natural, but one is congested in right lung</td>
</tr>
<tr>
<td>E. O. 27</td>
<td>policeman</td>
<td>bronchiolar glands, natural, but one is congested in right lung</td>
</tr>
<tr>
<td>J. B. 34</td>
<td>policeman</td>
<td>bronchiolar glands, natural, but one is congested in right lung</td>
</tr>
<tr>
<td>J. S.</td>
<td>policeman</td>
<td>bronchiolar glands, natural, but one is congested in right lung</td>
</tr>
<tr>
<td>Name</td>
<td>Condition of Lungs</td>
<td>Duration of Illness</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>B. C.</td>
<td>Bronchial enlarged</td>
<td>12 months</td>
</tr>
<tr>
<td>Housewife</td>
<td>on shoulder calcareaer mass, size of a small bean</td>
<td></td>
</tr>
<tr>
<td>H. L.</td>
<td>Bronchial glands enlarged</td>
<td>1 year</td>
</tr>
<tr>
<td>Clerk</td>
<td>Pulmonary nodes scattered</td>
<td></td>
</tr>
<tr>
<td>B. H.</td>
<td>Bronchial measures enlarged, but no evidence of calcareaer</td>
<td>1 year</td>
</tr>
<tr>
<td>Carpenter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. H.</td>
<td>Bronchial measures enlarged, but no evidence of calcareaer</td>
<td></td>
</tr>
<tr>
<td>Woman</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W.</td>
<td>Bronchial enlarged, one size of a horse bean was converted into a very fine calcareaer mass</td>
<td></td>
</tr>
<tr>
<td>Housewife</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. W.</td>
<td>No other evidence of calcareaer in the body</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
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<tbody>
<tr>
<td>Kirby (C)</td>
<td>Stones found in the lungs.</td>
</tr>
<tr>
<td>Kochel (R)</td>
<td>Uber die Kalkincrustation des Lungen- gewebes.</td>
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<tr>
<td>Kohn (H)</td>
<td>Zur entwicklung der corpora amylacea in der lunge.</td>
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<tr>
<td>Labalbarry</td>
<td>Etude sur les calculs pulmonaires.</td>
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<tr>
<td>Latte</td>
<td>Uber corpuscula amylacea in den Lungen.</td>
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<tr>
<td>Mager (W)</td>
<td>Ein Fall von broncholithiasis.</td>
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<tr>
<td>Malcolm</td>
<td>Calcareous bodies which were expectorated</td>
</tr>
<tr>
<td>Mare</td>
<td>Mort très prompte produit par plusieurs désordres dans divers organes.</td>
</tr>
<tr>
<td>Masen (C)</td>
<td>Observation de concretion cretacée, expulsée dans un cas de tuberculose pulmonaire.</td>
</tr>
</tbody>
</table>
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