

POST-OPERATIVE PULMONARY COMPLICATIONS

A STUDY FROM THE SURGICAL AND GYNÆCOLOGICAL RECORDS OF THE TORONTO GENERAL HOSPITAL, AND FROM THE DATA AND COLLECTION OF THE DEPARTMENT OF PATHOLOGY OF THE UNIVERSITY OF TORONTO

BY NORMAN B. GWYN, M.B.

Toronto

PART I*

A NEW interest was created in the subject of post-operative pulmonary complications by the articles of Pasteur,¹ Rose Bradford,² and later writers³ on the occurrence of massive collapse of the lungs following abdominal operations. Thanks to their insistence we were placed in the position of being able to recognize three cases of this peculiar lung condition within the short space of five weeks, and saw many other cases in a "chest wound" series, which seemed to typify Pasteur's description. These cases have been described and the clinical conditions referred to.⁴ They seem to be a post-operative happening found usually in direct proportion to the searcher's familiarity with the literature on the subject; they have symptoms of onset and certain physical signs which are unlike those of the more commonly noted post-operative lobular pneumonias.

As if to strengthen this newly created interest, and led chiefly by Wharton and Pearson⁵ and Wharton and Hampton,⁶ we have returned in the last few years to the recognition of the part played by emboli in the production of post-operative pulmonary complications; "minor emboli" in particular which tend to appear late in convalescence, imitate very closely an acute pleurisy, and are at times found to be in evident association with a thrombo-phlebitis of the femoral or abdominal veins. In giving careful consideration to the accumulating records concerning the so-called massive collapse of the lungs, one soon feels that some few of the acute pulmonary accidents which take place within a few minutes or hours of operation, are certainly happenings of this

nature. The analysis of any group of post-operative pulmonary complications gives also a very definite and large percentage of cases whose history suggests that minor emboli from thrombosed vessels at the site of the wound, or from thrombi elsewhere formed were causing the acute respiratory-system involvement. Massive collapse of the lung should be thought of when considering any extensive and rapidly formed consolidation occurring after operation; minor embolism is a diagnosis which should be freely made in the presence of a late developing pleurisy with or without an evident phlebitis. No tabulation of post-operative pulmonary complications can be looked upon as accurately analytical, if in its columns there be found no reference to these two conditions.

In most classifications of "the pulmonary accidents of surgery" it is recognized that lobar pneumonia, broncho-pneumonia and bronchitis—conditions which occur as a result of many contributing causes—are the most common pulmonary affections met with following operations under general anaesthesia. "Ether pneumonia", aspiration pneumonia, must be, however, a happening immediately related to the operation, and the diagnosis of post-operative pneumonia as a result of operation should be reserved for those cases which have developed their signs and symptoms within two and three days of the surgical procedure. It is admitted that a lung infection like lobar or lobular pneumonia may assail any patient in his convalescence, but it has never been sufficiently emphasized that a lung condition occurring suddenly, as late or later than four or five days after the operation (and there are many such) may be due to causes other than lung irritation, infection and inflammation.

* Part II of this interesting paper will be published in the August issue.

The diagnosis of "post-operative pneumonia" is still frequently made with a femoral thrombophlebitis in sight, a normal temperature, and the day of operation ten or twelve days gone by. Pulmonary accidents occurring under such circumstances are more certainly embolic in nature.

The well-kept records of the surgical and gynecological services of the Toronto General Hospital made an investigation of a three-year period of post-operative pulmonary complications an unusually easy matter; pneumonias, lobular pneumonias, bronchitis, pleurisies, empyemata, abscesses, gangrene, infarction, phlebitis, embolus and thrombosis were searched for under their respective headings and their relationship to the preceding operation carefully considered. An attempt was made to exclude from the series all septic cases, and those cases, which from their complications or bad physical condition, might be considered as likely to have developed pulmonary lesions, such as terminal pneumonias, or septic pulmonary emboli, even without the shock of an operation. With such restrictions, a comparison of the stormy post-operative period with a quiet or afebrile pre-operative stage, was frequently possible, and gave interesting suggestions, which would otherwise have been lost in the fever of infection or accompanying disorder. It was also endeavoured by an analysis of the history to estimate the life expectancy subsequent to the particular operation.

A further restriction was made in dealing with the question of pulmonary abscess as a post-operative pulmonary complication, if the abscess were attributable to inhalation of blood, secretions, or foreign body, or if following close upon operations on nose, mouth or upper air passages, it seemed reasonable to consider it as an aspiration result, rather than as something ensuing upon the mere surgical procedure. Emboli through the veins from the wound site in a tonsillectomy, or extension along the lymphatics to the lungs from the sloughing area left when dirty tonsils have been removed, have been popular explanations of the occurrence of lung abscess after these operations on the throat, but such explanations would not apply to an abscess following a clean sub-mucous resection, or to the abscesses following upon

teeth extractions and upon this latter operation ensued the majority of the pulmonary abscesses noted as being post-operative pulmonary accidents. The suspicion must still remain that aspiration of blood, secretions, or foreign body, into the lung is the more probable cause of pulmonary abscess subsequent to operations in the nasal, oral and pharyngeal cavities, though it will always be recognized that operations elsewhere in the body are at times associated with abscess and gangrene, which may have developed either from a post-operative lobular pneumonia or from an embolic infarction which has broken down as a result of an added infection.

Looking at post-operative pulmonary complications of clean surgical cases *en masse*, and in the light of some of the details just mentioned, one notes that they have a history and course which varies materially from that of the better known infectious lung disorders. The rapidity with which the temperature and pulse rate may rise after operation, when lung irritation is developing, is striking to a degree; within a few hours the picture of an acute diffuse lobular inflammation may be in evidence. The absence of both chill and pleural pain in the post-operative "pneumonias" suggests at once that a process different from that of the pneumococcus infections is developing; *herpes labialis* is rarely noted; neither serous or purulent effusions tend to accompany or to follow these post-operative pneumonias directly, though when an abscess has formed in one of them, it may have pus in the pleura as a complication or sequence. As regards the types of post-operative pulmonary accident with signs of acute pleural involvement in a clean case, it is to be insisted upon that they also are rarely associated with effusions; a feature which suggests that the irritating agent is non-infective in origin. It should be noted also as a point of clinical import that the infarctions associated with these pleurisies may be of an area large enough to provoke the diagnosis of a pneumonia.

The term so often used in this paper "subsequent to operation" as concerns the pulmonary accidents of surgery may almost be held to mean "subsequent to abdominal operations", for it is pre-eminently the operation on the abdominal viscera or pelvic organs that is followed by pneumonias, "minor-emboli"

pleurisy, or gross fatal embolic happenings. Operations upon the head, thorax or extremities are not, however, exempted from the liability to post-operative pulmonary lesions, as the following figures will show: "pulmonary complications subsequent to abdominal and pelvic operations, 102; subsequent to operations elsewhere in the body, 8." The determination of the nature of the pulmonary accident following upon an operation elsewhere than in the abdomen, is a matter of the greatest importance; one feels that the history of the cases analysed, indicates that fat embolism or thrombo-embolism has been the condition present rather than an outspoken lobular pneumonia.

The point of greatest interest in the study of the post-operative lung conditions is the distinguishing of the type of the pulmonary complication which has followed the operation; three distinct clinical groupings are clearly in evidence.

1. A large group of cases in which the respiratory signs occur quickly, or begin to develop within a few hours of the operation, and whose progress suggests a bronchitis or a lobular pneumonia. The majority of all post-operative pulmonary complications belong to this group, and in this group alone is seen a seasonal incidence. Possibly in these cases, since the great majority received ether, inhalation irritation and infection stand far forward in the ranks of causation. Rapid onset after operation, and absence of pleural pain are striking features which further suggest inhalation into the lung substance as a determining factor in the production of the lung injury. In this group must often be found the examples of massive collapse, and it should be remembered also, that the rare cases of fat embolism seen particularly after bone operations, and after operations upon the abdominal wall or breasts, may show their symptoms within the first few hours. The mortality in this type of post-operative pulmonary complication ranges from 20 to 60 per cent.

2. A group in which the record room filing is that of pleurisy. Investigation of these histories shows an almost regularly recurring picture. A clean operation is followed by a fever of 100°-103° for a few days with nothing to explain the cause thereof; this febrile period

of from three to eight days gives place to several days of normal temperature, one to twelve days, rarely more. Following the afebrile period there is the sudden appearance of an acute pleural attack, pain, rub and fever. The pleural attack may be repeated on the same side, or may appear upon the other. A femoral thrombo-phlebitis is a not infrequent complication appearing shortly after or with the pleural attacks, and should assist in the recognition of this type of pulmonary complication.⁸ It may be suggested also, that in many instances a thrombosis of abdominal veins is responsible for such a typical picture, a thrombosis not yet in evidence by any physical signs. The more outspoken phlebitis may perhaps be taken as indicating that the major portion of the thrombus has become adherent to the vein wall and will not migrate; fragments only are detached and the embolus is not large enough to endanger life. Pleuritis with pain, or a pleural rub, is allowed time to develop. Several of the cases diagnosed as post-operative broncho-pneumonia, and giving a history of acute pleural pain are distinctly better placed in this group; the late onset of the pleural and pulmonary signs, their appearance in an afebrile period of convalescence certainly delimit them from the cases of broncho-pneumonia developing immediately after the operation. The majority of the cases of this type of pulmonary complication recover.

3. The group of cases more clearly defined as gross emboli from thrombotic processes. These cases are more usually seen following operations in the lower abdominal area, and especially after operations for the removal of uterine and pelvic tumours.* They are practically always associated with thrombosis of the pelvic or femoral veins, and occur most frequently as late complications in the first and second week of convalescence. Like the cases of the foregoing group, they are preceded in their development by a fever wave of undetermined origin (the fever of thrombosis); they terminate fatally as a rule, and can be looked upon as cases of thrombosis in which the thrombus migrates in bulk to the lung, and by its size either kills at once or puts the patient's life in jeopardy for some hours.

* Seven of the twelve instances of gross emboli were recorded from the gynaecological service of Professor W. B. Hendry.

Some latitude in point of time of appearance must, of course, be given to thrombus formation and detachment. Possibly, there is a time of both early embolism from the wound site, and of later more serious embolism from thrombosis in the large veins. It would seem likely that a multitude of small emboli are early set travelling from the field of action at the time of the operation wound. Some have claimed⁹ that infarction resulting therefrom can be demonstrated in the lungs by x-ray investigation as a common event, and this even in the absence of symptoms. It would be difficult in the first few hours after operation to distinguish such embolic infarctions from pulmonary inflammation if they were seen about the lung hilus, particularly if a general anaesthetic had been given. In some instances, the suggestion of minor emboli with acute pleural symptoms may be given in the first twelve or seventy-two hours after operation; this is however unusual; a period of late thrombus formation, often in veins remote from the field of operation, seems a necessary part of the process. Massive emboli giving symptoms, and causing death within a few hours of the operation, are also to be reckoned with. Nevertheless, the majority of the large emboli are set wandering late in post-operative convalescence. Thrombus formation in the pelvic veins, particularly in the presence of large uterine tumours, is a well recognized condition quite apart from operation, and may give rise to fatal or serious embolic accidents unduly early in the operative or post-operative period. One of the cases analyzed in this collection died as a result of pulmonary embolism, less than twenty-four hours before the time set for an ovariectomy.* The association in many of these "embolic cases" of a femoral or pelvic thrombo-phlebitis may give a definite clue as to the nature of the pulmonary accident. It is further to be noted that a femoral thrombo-phlebitis occurs as a complication of clean abdominal wounds in a small but regular percentage of cases, and that of one hundred and twenty admissions indexed as phlebitis in three years' surgical records, not less than fifteen are post-operative, in clean cases, and of unexplained origin.†

The clinical grouping just outlined, a group-

ing founded on the facts as put before one, contains an evident suggestion, namely, that these forms of pulmonary lesions are the basic or primary post-operative lung accidents. Effusions, abscesses, gangrene, develop upon the lobular pneumonias and the minor, or the gross emboli. Future classification must give a place to both fat embolism and to massive collapse as basic lesions. There are no records as yet indicating that abscess, gangrene or purulent effusions follow upon these two conditions. Small serous effusions have co-existed with collapse of the lung in some cases; they may help to relieve the extreme negative pressure which must develop as the lung retracts. In cases with weakened heart action there might be considered the possible occurrence, as a primary lesion, of infarction of the lung without embolus.

The relation of post-operative, pulmonary accident to thrombo-phlebitis, its identity at times with massive collapse, fat embolism or even infarction, must be carefully borne in mind, when comparing the after effects of various forms of anaesthesia. A major operation done under a local anaesthetic will run the same chance of being followed by embolism as will the same operation done under general anaesthesia.* Massive collapse has been described as occurring after local anaesthesia, possibly in association with emboli.¹⁰ The bronchitis, and the lobular pneumonia, which ensue after crushing accidents, after operations on bone, and after operations in the fatty tissues of the breast and abdomen, are in many instances due to fat embolism, the symptoms of which are indistinguishable from a very acute progressive lung inflammation due to infection and aspiration.¹¹ A study of the cases of post-operative pulmonary complications which have followed the use of a local anaesthetic will reveal the fact that singularly few of them have shown the signs and symptoms of an active lobular pneumonia beginning in the first few hours after operation. It will usually be demonstrable, on the other hand, that these cases occur late and have symptoms suggestively embolic. An acute bronchitis, a lobular pneumonia, following quickly after local anaesthesia, should always suggest the diagnosis of fat

* Gynaecological records, No. 53,572.

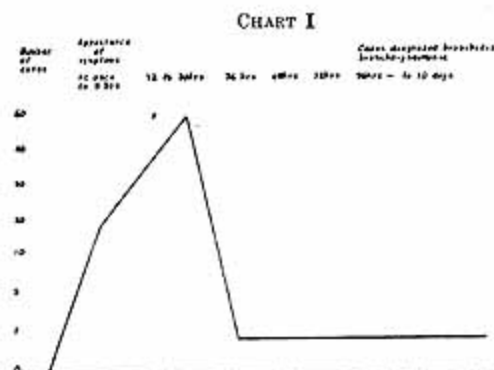
† Surgical records, service of Professor C. L. Starr.

* Unless of course the "acidosis" of general anaesthesia has some "thrombogenic" influence.

embolism, and one must in fairness add that many deaths after the use of a general anaesthetic have not been due to aspiration pneumonia, but to an intense irritation from the fat deposited in the lungs subsequent to its being set free by crushing of marrow, or laceration of other fatty tissues. The general anaesthetic and the aspirated secretion must always be suspected however, of being active contributory agents in the production of acute post-operative lobular pneumonia, and if it be shown that thrombo-embolism, fat embolism, and massive collapse are the only lung accidents which follow local anaesthesia, then these two agents are more than ever to be blamed in seeking to determine the cause of the inflammatory lesions of the lung met with after operation.

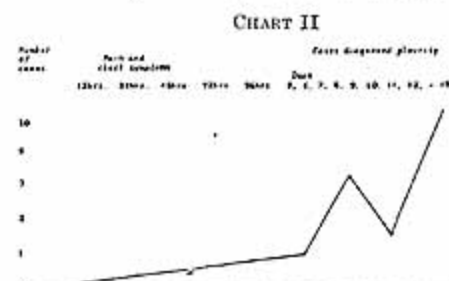
It is difficult to believe that post-operative pulmonary accidents follow indiscriminately any form of anaesthesia. It is difficult to imagine the administration of a local anaesthetic being attended with an inflammatory or bacterial lung complication. Five instances of "lobular pneumonia" in our series are recorded as being subsequent to major operations under novocaine, anocaine or cocaine alone; two of these cases are clearly embolic accidents late in convalescence; one is a lobular pneumonia complicated with a peritonitis six weeks after the operation; one is a late occurring unilateral consolidation, seventy two hours after operation. In only one case, a bronchitis, do the symptoms of lung irritation and signs of infection (fever) develop in the early post-operative period.

It is a recognition of this defined relation of anaesthetic to the lung lesion, and the realization of the clinical grouping of the cases before given, that invites the suggestion that the majority of pulmonary affections of the early hours or days after operation are inflammatory, and dependent largely upon irritation and infection, probably from the anaesthetic and aspiration; while those occurring later than the third or fourth day after operation are suggestively due to other causes and may be ascribed to emboli and infarction from a recognized or unrecognized thrombosis. Chart I shows how clearly related to the operation in point of time are the cases listed as pneumonias. Of six cases evidently not belonging here but diagnosed as pneumonia and occur-



The period in hours after operation in which "irritation lesions" appear.

ring later than forty-eight hours after operation, one was a developed pneumonia with severe abdominal pain subjected to laparotomy but with negative findings; one developed temperature and signs of lung involvement three days after operation, a note says "trachea was drawn to the left" and massive collapse is suggested by the history; two with fever following the operation, but with no lung signs, die with the classical symptoms of embolism on the tenth and twelfth day of convalescence; two run the course ascribed to "minor embolism"; a post-operative fever of undetermined origin; a fever free period; then the outbreak of acute pleural symptoms. A chart constructed in the same manner as the preceding, shows how late in the convalescence acute pleuritis and gross emboli tend to be seen (Chart II). Several of the cases dia-



The period after operation, in hours and days, in which acute pleuritis tend to appear.

nosed as bronchitis, broncho-pneumonia or pneumonia, indicated by their symptoms and time appearance that they were better placed in this group of late appearing lesions. In most of the instances of fatal emboli and acute pleural involvement in the post-operative period, a slight fever wave lasting three to sixteen days, is seen to develop upon the operation, and to be followed

by an afebrile period of from three to fourteen days: after such an interval as a rule ensued the sudden death, the intense dyspnoea, or the outbreak of pleural pain and pulmonary lesion.

The course followed by the temperature record of these post-operative pulmonary embolism cases, the minor and the gross, is noteworthy and may be looked upon as typical of the condition; too little attention has been paid to the symptoms and signs of thrombosis which may follow a clean surgical procedure; sudden death is the usual terse and tragic history without any recognition of the fact that a warning has been early sounded in the unexplained post-operative fever, "the fever of thrombosis", to use the words of some observers. It has long been insisted upon by the gynæcological surgeons that pulmonary embolism from thrombosis of the pelvic or femoral veins is the most common cause of death subsequent to hysterectomies, ovariectomies or operations in the pelvis. The slight fever existing before operation in two cases of hysterectomy for large fibroids might be taken as indicating that thrombosis of the pelvic veins was already in existence (cases 45,469 and 54,463); the interesting history of case 53,572, dying a few hours before the time set for operation and showing at autopsy extensive thrombosis of the veins of the pelvis and massive pulmonary embolism is probably duplicated in the records of any large hospital.

Presented in the form above suggested, the early irritative and the late embolic lesions, post-operative pulmonary complications may perhaps offer themselves for a readier recognition than heretofore. The early irritative forms would include the rare examples of massive collapse of the lungs, the lobular pneumonias due to aspiration-irritation and fat embolism. The later embolic lesions would embrace the pleuritis and infarctions due to minor embolic accidents and the more readily appreciated sudden deaths or

urgencies attributed to the gross emboli. Thrombo-phlebitis acquires a new importance if found existing co-incident with these pulmonary accidents; its bearing upon post-operative fevers of undetermined origin has been indicated and its relationship to late occurring "infarction-consolidation" should be always borne in mind when making a diagnosis of a pleurisy or pneumonia¹² late in the operative convalescence.

REFERENCES

- (1) PASTEUR, *Brit. Jour. Surg.*, 1914, i, 587. *Lancet*, 1908, No. 2, 1351. *Lancet*, Jan. 2, 1908 and May 20, 1911. *Arch. Middlesex Hospital*, 1910. Pearson Irvine quoted by Pasteur. (2) BRADFORD, ROSE, *Brit. Jour. Surg.*, iii, 247. *Brit. Med. Jour.*, Aug. 6, 1917. *Quart. Jour. Med.*, Oct., 1918 and Jan., 1919. (3) ELLIOTT AND DINGLEY, *Lancet*, May 9, 1914. CRYMBLE, *Brit. Jour. Surg.*, Jan., 1918. SCRINGER, *Am. Jour. Surg.*, April, 1922, xxxvi, 53, and *Surg., Gyn. & Obst.*, 1921, xxxii. HIRSCHBROEK, *Am. Jour. Med. Sci.*, 1922, p. 164. SCOTT, W. J. M., *Arch. Surg.*, Jan., 1925, x, 73-116. LEOPOLD, *Am. Jour. Med. Sci.*, March, 1924. ELWYN AND GIRDANSKY, *Jour. Am. Med. Ass.*, Aug. 26, 1922, lxxix, 718. (4) GWYN, *Trans. of Ass. Amer. Phys.*, 1923, xxxviii. (5) WHARTON AND PIERSON, *Jour. Amer. Med. Ass.*, Dec. 2, 1922. (6) WHARTON AND HAMPTON, *Bull. Johns Hopkins Hos. Med. Soc.*, 1920. (7) WOOD AND FETTEROLF, *Am. Jour. Med. Sci.*, Dec., 1923. (8) WHARTON AND PIERSON, *Vide Supra*. SCHENK, *Surg., Gyn. & Obst.*, 1913, xvii. (9) WHIPPLE, *Surg., Gyn. & Obst.*, 1918, xxvi. *Am. Jour. Surg.*, Jan., 1919. (10) ELLIOTT AND DINGLEY, *Vide Supra*. DEQUERVAIN, *Surg., Gyn. & Obst.*, 1922, xxxiv. (11) BISSELL, *Surg., Gyn. & Obst.*, 1917, xxv. PARK, ROSWELL, Fat embolism, *New York Med. Jour.*, 1884, xl. CALDWELL AND HUBER, *Surg., Gyn. & Obst.*, 1917, xxv. (12) CONNORS, Thrombo-phlebitis in typhoid, pulmonary attacks simulating lobar pneumonia caused by embolism from latent thrombosis, *Arch. Int. Med.*, 1912, x. *Med. Rec.*, April 29, 1911. GERHARDT, *Volkman's Sammlung*, No. 91. (13) Post-operative pulmonary complications. BEEKMAN, Mayo Clinic, 1913. CUTLER AND MORTON, *Surg., Gyn. & Obst.*, 1917, xxv. ELWYN, *Jour. Am. Med. Ass.*, Feb. 2, 1924. CUTLER AND HUNT, *Arch. of Surg.*, July, 1920, i, 114. LEE, *Ann. of Surg.*, April, 1924, lxxix, 506. SAUERBRUCH, *Munch. Med. Woch.*, Sept. 2, 1913. CALDWELL AND CLEVELAND, Acidosis in general anaesthesia, *Surg., Gyn. & Obst.*, 1917, xxv. (14) ASCHOFF, Beiträge zur Thrombosis Frage, Leipzig, 1912. FARRAR, Pulmonary embolism after hysterectomy, etc., *Am. Jour. Obst. & Gyn.*, 1912, ii. WELCH, W. H., Embolism and thrombosis. ALBUTT, System of Med. KARSNER AND ASH, *Jour. Med. Resear.*, 1912-13, xxvii. RANZI, *Archive für klinische Chirurgie*, 1908, lxxxvii, 380-410. (15) JACKSON AND LEE, *Ann. of Surg.*, Sept., 1925; including references to Chevalier Jackson.

POST-OPERATIVE PULMONARY COMPLICATIONS

A STUDY FROM THE SURGICAL AND GYNÆCOLOGICAL RECORDS OF THE TORONTO
GENERAL HOSPITAL, AND FROM THOSE OF THE
DEPARTMENT OF PATHOLOGY IN THE UNIVERSITY OF TORONTO

BY NORMAN B. GWYN, M.B.

Toronto

PART II*

FROM both a clinical and statistical standpoint the subjoined analysis may be of value in discussing the pulmonary lesions of the post-operative period.

I. Autopsy Findings.

(a) In cases dying with symptoms of large pulmonary emboli.

Case 1.—Hysterectomy: thrombosis or embolism of pulmonary artery; no note on condition of pelvic or abdominal veins.

Case 2.—Repair of cystocele: thrombus of right and left pulmonary artery; thrombus of right hypogastric vein.

Case 3.—Hysterectomy: fibroid of uterus, pulmonary embolus and infarct; thrombosis of femoral veins of the broad ligament.

Case 4.—Removal of varicose veins of the leg: "pulmonary thrombi"; no dissection of other veins.

(b) In cases described as acute pleurisy and showing the late onset of symptoms suggestive of the condition labelled "minor embolus."

None of this type of case came to autopsy. This is not to be taken as indicating that such cases are invariably fortunate; late death from development of abscess followed in one case, and death with the symptoms of a gross embolus occurred in another whose subsiding pleurisy had suggested the diagnosis of minor embolus (case 53845). Fatalities however are distinctly less common in this group of cases.

(c) In cases considered as having been post-operative broncho-pneumonia, bronchitis or pneumonia.

In eight complete autopsies the description of the post mortem findings is regularly stated to

be "lobular pneumonia of right and left lung" with an occasionally added note of abscess or of gangrene†. No lobar fibrinous pneumonia resembling an acute pneumococcus infection was met with in the three years. Two of the autopsy descriptions are very suggestive of massive collapse of various lobes of the lung accompanying the broncho-pneumonia. In one of these (49439) the clinical history of rapidly increasing urgency of respiration with suggestive physical signs, had provoked the employment of the aspirating needle on the right side with a very negative result—one c.c. of clear fluid. At autopsy two days later the existence of lobular pneumonia of both lungs was determined, but of the right upper lobe the note is made "that it is collapsed, purple in colour and of a rubbery consistence." In number 52353 of the series, large areas of collapsed lung were found at autopsy, co-existent with the broncho-pneumonia.

In none of these cases of lobular pneumonia has the pathologist indicated that infarction and embolism had played a part in the lung picture, yet two of the autopsies are recorded as having been made on the second and fourth days respectively of the lung complications, a time at which the picture of embolic infarction, if present, might well be expected to have been noted. Abscess and gangrene are noted as having been found; there was no instance of effusion, either serous or purulent, complicating these fatal lobular pneumonias, subsequent to clean operations.

Concluding the summary of the autopsy findings it may be said, first, that the existence of pulmonary embolism and infarct in association with femoral or pelvic phlebitis is a picture clearly drawn; careful search in all the large

* Part I, *Can. Med. Assoc. Jour.*, July, 1926, xvi, 772.

† One instance of each.

veins of the body is imperative in the face of a fatally ending pulmonary embolism. Second, that a lobular pneumonia is the most common autopsy finding in the cases diagnosed as dying of lobular pneumonia; descriptions of infarctions are lacking in the autopsy notes dealing with this class of case. Third, that the proof of the actual existence of the minor embolus will always be difficult to establish. Fourth, that a condition suggesting massive collapse of the lung was noted as being present in two of the autopsies; and finally that pleural effusions must be looked on as unusual complications of the post-operative pulmonary lesions.

II. *Analysis of Post-Operative Pulmonary complications of Clean Surgical procedures According to the Clinical Evidence.*

A careful investigation of 125 case records showed that the pulmonary lesions subsequent to operation could be fairly sharply partitioned into the following classes:

(a) Cases occurring early in the post-operative period, within seventy-two hours, and showing the signs and symptoms suggestive of lobular pneumonia, bronchitis, fat embolism or massive collapse, (Chart I); these were divided into the following groups: lobular pneumonia and bronchitis, 84 cases; recovered 56; died 28; mortality 33.3 per cent. Fat embolism (suggested), 2 cases; recovered 0; died 2; mortality 100 per cent. Uncomplicated massive collapse, (suggested), 2 cases; recovered 2; died 0; mortality 0.

(b) Cases giving the history of an acute pleurisy, or showing the more evident signs of pulmonary embolism, and occurring later in the post-operative period than the pneumonic type of post-operative accident (after seventy-two hours) Charts II and III. The twenty-four cases of this group were divided into: minor emboli pleurisies, 12; recovered 11; died 1; mortality 8.3 per cent. Gross pulmonary emboli 12; recovered 1; died 11; mortality 91 per cent. The "minor embolus" fatality had recovered from his pleurisy (minor embolus) only to succumb to a later gross embolism; the recovery noted in connection with the gross emboli cases, and the physical conditions noted in his lungs suggest that an accident other than embolus caused his symptoms; a massive collapse was indicated by the signs presented.

(c) Cases more distinctly secondary in character: First, those cases of abscess and gangrene which ensued upon lobular pneumonia, bronchitis and embolus rather than upon foreign body inhalation, or upon the inspiration of infected or highly irritating secretions. Second, cases of effusions, serous or purulent. Of the effusions it may be said that they do not seem to follow the lobular pneumonia of the post-operative period; one serous effusion ensued upon a minor embolus; empyema was seen once as an association of abscess. These secondary lesions were met with as here detailed:—

Abscess subsequent to conditions suggesting lobular pneumonia or bronchitis, 6; fat embolism, 0; massive collapse, 0; minor embolism, 4; gross embolism, 0; gangrene, one instance only, and subsequent to a lobular pneumonia, 1; serous effusion subsequent to lobular pneumonia or bronchitis, 0; serous effusion subsequent to minor embolism, 1; serous effusion subsequent to fat embolism, massive collapse or gross embolism, 0; purulent effusions subsequent to lobular pneumonias or bronchitis, 0; purulent effusions subsequent to fat embolism, massive collapse or gross embolism, 0; purulent effusions in association with abscess, which in turn had seemed to have developed from a minor embolus, 1.

III. *The Clinical Course of Post-Operative Pulmonary Complications as seen in Clean Surgical Procedures.*

(a) *The lobular pneumonia and bronchitis cases.*—A temperature rising high even before the patient was completely recovered from the effects of the anæsthetic was frequently noted (c.f. cases 49434, 50538, 47062); the pulse and respiratory rate were usually rapidly elevated and in the course of a relatively few hours after the operation patients were reported as seriously ill (See Fig. 1). The early developing cyanosis in case 50358 with the signs of lobular pneumonia suggested the occurrence of fat embolism. Suddenly appearing dyspnoea in case 53213 suggested the diagnosis of thromboembolism, a diagnosis rendered less probable by reason of the patient's recovery and by the signs subsequently in evidence of displacement of the mediastinum. Displacement of the trachea and of the heart as recorded in cases 49369, 51039, 52051, 52572, 53213, indicate that with the pneumonic condition there had oc-

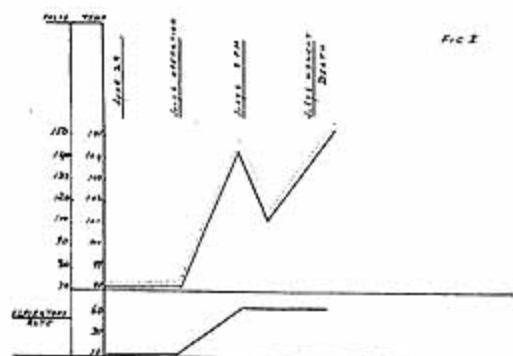


FIG. 1.—Rapid onset of symptoms in post-operative lobular pneumonia.

curring a collapse of the lung of greater or less degree. In the less severe types of lobular pneumonia a moderate fever range of from 101° to 103° lasting on the average six days, and ending by lysis, was the usual picture. The steady line of the fibrinous lobar pneumonia temperature was never in evidence and no crisis was observed; rusty or bloody sputum was noted but twice. It must be remembered that the bloody sputum of pulmonary infarct might easily pass as a sign of a pneumonic infection, particularly if co-existent with a painful minor embolus; also the occurrence of bloody sputum at a later time of convalescence would be in itself a happening most suspicious of embolic infarction.

Unlike the pneumonias of the medical wards, the post-operative lobular pneumonia rarely announces its onset with a chill; in three cases only were chills mentioned as having occurred. In one of these the chill took place three days after the pulmonary lesion was established and was due to the development of an abscess in the wound tract; in a second case, diagnosed as lobular pneumonia the chill was on the twelfth day after operation and signaled the occurrence of a fatal pulmonary embolism; in the third case a chill thirty-six hours after operation preceded the development of a consolidation in the left base.

Just as noticeably absent in the outspoken post-operative pneumonias, as were chills, was the detail "pleural pain", and one recognizes that neither chill nor pleural pain belongs to the inflammatory lesions of the early days and hours, but is usually something of the later stage of convalescence and is more suggestive of thrombosis and embolism. Of four cases

diagnosed as lobular pneumonia or bronchitis of the post-operative period, and having pleural pain as part of the condition, one has the following history: male, age twenty-nine, chondroma of the eleventh rib on the right side; resection; slight temperature for five days after operation, some few râles and rhonchi noted in the lungs; on the sixth day, acute pain in the left chest with the development of the physical signs of consolidation, and a history, which is that of embolism of the minor type rather than that of post-operative lobular pneumonia. Two cases were outspoken instances of pulmonary embolism with the pain occurring as late as the sixth and the eighth day, (52572, embolism of minor type and collapse; 53845, minor and gross embolism). The fourth case, number 45923, stands alone amongst the lobular pneumonias in having acute pleural pain as a feature of its onset, and even in this particular instance of "pleural pain in lobular post-operative pneumonia" the physical signs were entirely unilateral.

A striking feature of the course of all the lobular pneumonias, which ensued after operative procedures was, that in none was there recorded the occurrence of endocarditis, pericarditis, arthritis, peritonitis, arteritis, meningitis, nephritis, otitis, save in those cases which were badly infected at time of operation.

Phlebitis, when found, was not a happening clearly subsequent to a pneumonic process; it was never seen save as an unexplained post-operative phlebitis, or as the intimate associate of embolism. (cases 45469, 4319).

The high mortality of the post-operative lobular pneumonia has been noted; death was usually an incident of the early days and would seem best ascribed to toxæmia and anoxæmia, for cyanosis was a feature of the condition. In the recovered cases, lysis without complication was the rule. The one empyema recorded occurred late after an illness which suggested that an abscess had been present; one serous effusion which had only amounted to one c.c. of fluid existed in association with a collapse of the right upper lobe; the sudden onset of dyspnoea during the course of a lobular pneumonia had provoked the attempt at aspiration of the then completely consolidated right side;

the autopsy showed only lobular pneumonia and collapse.

The statement can be made that pleural effusions do not seem to accompany the pneumonic process which may follow clean surgical performances; they are in fact only to be looked for as an association of abscess or embolus. This tendency to escape the added handicap of effusion into the pleural sacs would almost seem to distinguish the pneumonia following a clean surgical procedure from one of the infectious type.

As further indicating the difference between the "surgical" and the "medical" pneumonias, can be mentioned the incidence of abscess of the lung in the cases whose histories suggest that suppuration has taken place in a simple inflammatory condition, rather than around an inhaled foreign body, or in an embolus which had become secondarily infected. Five instances of lung abscess and one of gangrene were found amongst the eighty-six cases whose clinical course had suggested post-operative lobular pneumonia, a considerably higher percentage of abscess than is looked for in the acute pneumococcus infections of the lung.

(b) Cases which make up the group of "minor emboli," cases with acute pleural pain and signs of a localized lesion in the lungs, the complete picture developing late during post-operative convalescence.

Absence of symptoms of respiratory or cardiac distress is the rule for several days immediately after the operation. The existence of an unexplained slight elevation of temperature and pulse rate for some days is usually demonstrable; suppuration in the wound tract may be suspected and the incision re-opened;* a period of complete well-being usually follows the primary fever wave, and is terminated by the onset of acute pleural pain, after which a small area of consolidation and a pleural rub can be demonstrated in most cases. The pleurisy may be re-produced on the other side; dyspnoea, cough and a short fever wave ensue with a moderately increased pulse rate; bloody sputum is not often seen (case 45910). The most typical instances of these pulmonary complications show evidence of a femoral phlebitis at the time of the first pleural attack

or a few days later. These cases are of such an unusual nature that their accurate delineation is desirable and their labelling as instances of pleuritis in association with minor emboli is urged. The details of some of the most typical of these cases might be given.

Case 4319. Female; age twenty-one. Appendectomy under ether. Slight fibrosis of the appendix was found but no inflammation. After operation slight fever for six days which fell to normal for one day, then pleuritic pain and a pleural rub occurred on the right side with temperature of 100° lasting one week. An impaired percussion note and distant sounds were noted on the right side over the site of the pleural pain. On the seventeenth day, phlebitis of the left leg; on the twenty-fourth day an attack of pleurisy with pain again on the right side; recovery.

Case 51021. Male; age forty. Gangrenous appendix, operation under ether, slight temperature before operation reaching 100°, remains elevated for eight days, drops to normal; then pain in the right side with friction rub; recovery.

Case 52572. An infected case at operation and one in which the early fever of thrombosis would be hidden by the fever of infection. Female; age thirty-three. Pyosalpinx, pelvic peritonitis, incision and drainage under ether. The fever which was present at operation fell in four days and temperature was normal for two days. On the sixth day there was sudden pain in the chest with dyspnoea, there was found a pleural rub with signs of consolidation on the left side. Complete recovery.

Viewed from the clinical side it is apparent that the extreme urgency, the collapse, the quickly developing signs of cardiac and respiratory failure belonging to the gross emboli are not as a rule so much in evidence in these minor emboli cases as is the acute pleural pain. It may be said as before suggested, though with many reservations, that the persisting pleural pain goes hand in hand with persistence of life and reaction. No distinct instance of collapse of the lung was associated with this group of minor emboli; a

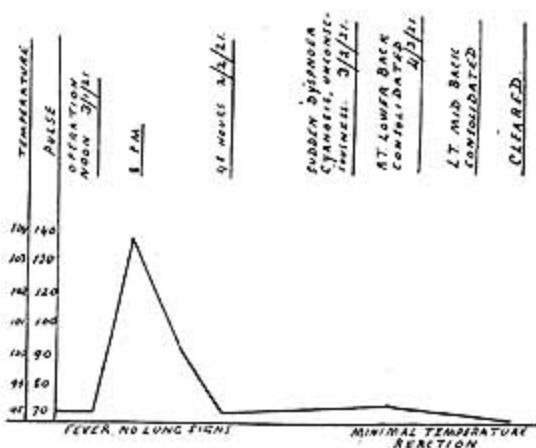


FIG. 2.—Embolism. Recovery. Called pneumonia.

* As in the case whose chart is given as Fig. 3.

distinctly demonstrable consolidation is not the rule; a pleural rub is often the main evidence of pleuro-pulmonary involvement; a large effusion (sterile) followed in only one instance.

The usual tendency of these cases is to declare themselves by pleural pain or rub; they may however be singularly unostentatious in their arrival and almost lacking in their temperature reaction (Fig. 2). Conner has demonstrated how often latent pulmonary lesions exist with the phlebitis of typhoid fever; a study of his descriptive cases shows how closely the course of the post-operative minor emboli cases resembles that of his "pulmonary manifestations of typhoid phlebitis." Resolution without complication is the rule; the history of four of the "abscess of the lung" cases, however, indicates clearly that even without the suspicion of being a carrier of infection, the minor embolus may terminate in suppuration of the lung. (31337, 5509, 2666, 29444). The two accompanying sketches (Figs. 3 and 4.) show well the early

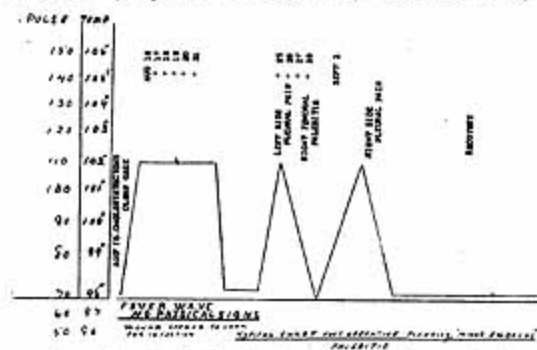


FIG. 2.—Typical chart, post-operative pleurisy, "minor embolus," phlebitis.

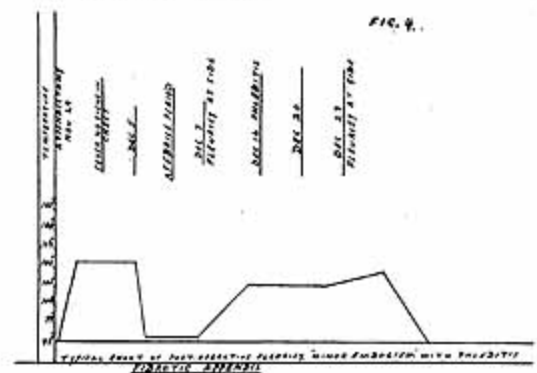


FIG. 4.—Typical chart of post-operative pleurisy, "minor embolism" with phlebitis. Fibrotic appendix.

fever wave, the drop to normal, and the late occurring pleurisy; in both cases the causal phlebitis was in evidence.

(c) *Clinical course of the gross, fatally ending, emboli.*

The classical picture of pulmonary embolism need hardly be retraced: death, sudden and unexpected, is the tragically simple sketch in no less than five of the cases of embolism; dyspnoea, sudden in onset, with oppression rather than sharp pleural pain, cough, rapidly rising pulse rate, symptoms of shock and exhaustion, may at times be more positively identified in those cases whose death has been postponed for some hours. Cyanosis may or may not be present; a mucoid expectoration was observed in one instance; the bloody sputum of infarct is probably associated only with those cases who survive the primary shock by many hours. The rapid, weak pulse and signs in connection with the heart may suggest a diagnosis of some form of cardiac failure, such as dilatation or the various conditions of tachycardia. Should there be time for the development of pain in the anterior situation, coronary thrombosis may be suspected; "abdominal hæmorrhage and shock" was the suggestion in one case (54035) and the abdomen has been re-opened in cases of pulmonary embolism, whose symptoms suggested hæmorrhage and shock rather than a lung condition. It is very evident, since signs common to both cardiac and pulmonary involvement will be present, that the determination and delimitation of the actual condition will be difficult. The fact that an abdominal operation has preceded the sudden death or urgency, the persistence of an unexplained fever after operation, the co-existence of a femoral phlebitis, are all details pointing suggestively in the direction of an embolic cause for the debated accident. Neither a pleural rub, or a localized consolidation was detected in any of our cases which ended fatally—a turmoil of râles and over-active respiratory sounds conceal the true condition. "A pain in the left chest," "pain at mid-sternum at third costal cartilage" in two cases, had no accompanying pericardial rub to suggest a coronary thrombosis; a diagnosis which must be suggested under the circumstances. The latter of these two cases coming to autopsy showed only embolism of the pulmonary artery and infarct. The co-existence of smaller emboli and massive collapse must be considered. Case 53213 listed as

pulmonary embolus, but to be described later amongst the "collapse-of-the-lung cases", is suggestive of this happening, and the recovery recorded here may make one question as to whether embolus was the actual condition present.

Fever beginning with the operation and dropping to normal before the fatal outcome was a feature in seven of the twelve cases listed as gross pulmonary embolism and as has been before insisted upon, this fever without evident

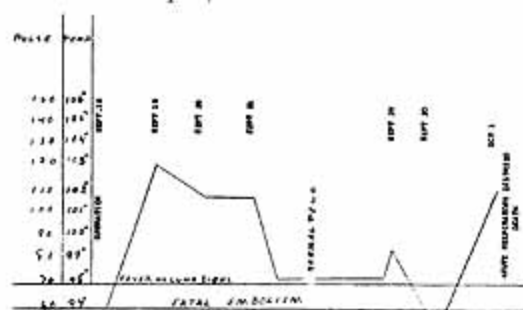


FIG. 5.—Fatal embolism.

Nature of operation	Fever	Death	Notes
1.—Hysterectomy. Case No. 45469	Slight before operation.	Sudden, 5th day.	Sudden onset of acute dyspnoea.
2.—Hysterectomy. 7989	None.	Sudden, 10th day.	No symptoms noted.
3.—Hysterectomy, fibroids. 54463.	Slight before operation.	Protracted to a few hours, 10th day.	Pain at third costal cartilage; phlebitis of pelvic veins, femoral veins and veins of broad ligament.
4.—Salpingectomy and Ovariectomy. 54035	Slight after operation.	Protracted to a few hours first day.	None noted save that of "sudden death."
5.—Hysterectomy, tumour. 51890.	Slight for five days after operation.	Sudden, 9th day.	"Thrombosis in pulmonary arteries."
6.—To have:—Cystocele repair. "No operation." 53572.	None.	Sudden, 4th day in ward.	Embolism of pulmonary artery, thrombosis of hypo-gastric veins.
7.—Removal of varicose veins. 52769.	None.	Sudden, 4th day.	No notes save that of sudden death.
8.—Ventral hernia repair. 48702.	Slight for two days after operation.	Sudden, 3rd day.	Cyanosis and dyspnoea.
9.—Gastro-enterostomy. 51770.	Began in 24 hours, lasted 3 days, normal 2 days.	Sudden, 12th day.	Chill and dyspnoea preceded death.
10.—Gastro-enterostomy. 53845.	Slight for ten days after operation.	Sudden, 11th day.	Preceded by an attack of minor embolism.
11.—External urethrotomy. 49718.	Slight fever falls with operation.	Sudden, 18th day after operation	Phlebitis 16th day.
12.—Amputation of breast. 53213.	For four days after operation.		Recovered. Lung signs on second day. Consolidation and heart displaced to right. Question as to massive collapse.

FIG. 6

signs of infection, called by some "the fever of thrombosis" is a frequent forerunner of the embolic incident, and its disappearance is no guarantee of the patient's well-being. In Fig. 5 is drawn what might be called the more or less typical course of fatal pulmonary embolus subsequent to operation.

The details of eleven operative cases diagnosed as pulmonary embolism either at the time of the accident or, as in case 10, in the subsequent revision of the history, are charted in Fig. 6. The large proportion of these cases of sudden death from the gynæcological service bears out the statement of one author that pulmonary embolism is a common cause of death after the removal of large uterine tumours. It is apparent that the emboli have a preferred time of late appearance.

IV. Less Readily Recognizable Post-Operative Pulmonary Complications.

Any classification of post-operative pulmonary complications should include detailing of such

conditions as fat embolism, the acutely occurring instances of massive collapse and of acute mediastinitis. No such diagnoses were made in the three years' records covered by this investigation. Fat embolism is suggested by the history in case 48399, (a cranioplasty) from the nature of the operation with the accompanying chipping and hammering of the bone; and much more particularly in case 50538, (an operation for ventral hernia repair using living suture) which was followed by immediate collapse and death. These are the types of operations which are most often credited with the causing of fat embolism. (Park: Bissell). Cases 51039, 53213 and 52572 with the actual dislocation of the mediastinum recorded, create the suspicion at least that the condition of collapse of the lung does occur as a post-operative pulmonary lesion. Their details are as follows:

Case 51039. Carcinoma of transverse colon; entero-enterostomy; elevation of temperature, pulse rate and respiratory rate after operation; the note is made that with the lung signs of consolidation the "trachea is drawn to the left".

Case 53213. Radical operation on the left breast; slight temperature next day, pulse rate 140, this disturbance lasting four days. Four days later sudden onset of extreme dyspnea and cyanosis, physical signs vague as wounds prevent complete examination, but heart is noted as one inch to the right of sternum, the patient recovered. As above noted the diagnosis of embolism in this case seem open to question.

Case 52572. Double pyo-salpinx; pelvic peritonitis incision and drainage; slight temperature fell in four days to normal; on the sixth day pain in chest, signs in both bases, and note says "apical impulse in axilla." This though an infected case is here quoted and detailed to illustrate the conditions which must be held to suggest massive collapse.

V. *The Life Expectancy and the Condition of the Patient as Regards Probable Recovery from the Actual Operation in Cases Subsequently Affected with Post-Operative Pulmonary Complications.*

A. CASES CONSIDERED AS VERY GOOD RISKS.

No.	Average age	R	D	Pneumonia; Broncho-Pneumonia	Minor emboli	Embolism-Thrombosis	Abscess
38	37	29	9	25	5	3	5
			Deaths—	4	0	3	2
						Percentage of mortality	23.6

B. CASES CONSIDERED AS MERELY GOOD RISKS.

No.	Average age	R.	D.	Pneumonia; Broncho-pneumonia	Minor Emboli	Embolism-Thrombosis	Abscess
35	37.6	26	9	27	2	3	3
			Deaths—	6	0	3	0
						Percentage of mortality	25.7

C. CASES CONSIDERED AS DOUBTFUL RISKS AT OPERATION.

No.	Average age	R.	D.	Pneumonia; Broncho-pneumonia	Minor Emboli.	Embolism-Thrombosis	Abscess
34	51.8	13	21	26	0	3	5
			Deaths—	15	0	3	3
						Percentage of mortality	61.7

Whether the subject be labelled "questionable risk," "good risk," or "very good risk," it is clearly evident that he is liable to post-operative pulmonary complications and the further away he is from the rating "very good" the more terribly apparent the seriousness of the outlook in the ensuing complication. To realize that a strong adult who acquires a lung complication after an operation runs a 20 per cent risk of death even if he is a perfectly clean case indicates clearly the gravity of the complication. Deaths from broncho-pneumonia subsequent to operation were recorded as terminating the following more or less quiescent complaints in distinctly young and vigorous people.

1. Sub-acute cholecystitis and appendicitis: age fifty-one.
2. Chronic appendix, pathological record of fibrosis: age twenty-one.
3. Appendix operation, pathological record of "nothing found": age twenty-six.
4. Ventral hernia repair: age thirty-four.
5. Sub-mucous resection, development of lung abscess: age forty.

The absence of minor emboli as a cause of death is noteworthy. This has already been touched upon in discussing the prognosis of post-operative pulmonary complications. A very typical case of minor emboli with accompanying phlebitis is recorded as following an operation for appendectomy in one case, the pathological report showing no change in the removed appendix. Three deaths from embolus, in young adults, raise the mortality percentage in those cases labelled very good risks. An operation for varicose veins of the leg in a man sixty-five years of age brought

low by hæmorrhage, and an operation for cystocele in a woman of sixty-one would seem to be conditions in which expectancy might be labelled questionable, and emboli ending fatally in these cases, help to make the shocking mortality figures of post-operative pulmonary complications in the so-called poor risks.

VI. *Nature of the Operation and the Type of Pulmonary Lesion.*

The predominance of the abdominal operation as a detail in the history of a post-operative pulmonary complication has been noted. The close association of abscess with nose, throat and mouth operations and of gross embolus with operations in the pelvis is clearly evident; appendectomies, operations on the biliary tract, gastro-enterostomies, make up the largest percentage of abdominal operations and they show the greater relative incidence of broncho-pneumonias. Minor emboli are recorded most frequently subsequent to appendectomy, hysterectomy and salpingectomy. One cranial plastic operation No. 48399 was complicated by a rapidly developing and fatal broncho-pneumonia; the isolated instances of fat embolism recorded in literature are often found to be in association with such procedures, and fat embolism should be thought of when considering any acute pulmonary affection developing subsequent to operation upon bones. The same remark applies to pulmonary conditions developing after operations which require dissecting or manipulating of fatty tissues such as the breasts or the abdominal wall. The acuteness of onset of the symptoms of fat embolism and the special pathological technique necessary to demonstrate the actual lesion were well put before the profession many years ago by Roswell Park. Massive collapse is spoken of as more closely related to operations nearer the diaphragm.

VII. *Relation of Anæsthetic to the Post-Operative Pulmonary Complications.*

The operation, rather than the anæsthetic, determines the occurrence of the post-operative pulmonary complications (Steinach). In three years, at the Toronto General Hospital 17,000 general anæsthesias with ether, in all types of surgical procedures were followed by 200 post-operative pulmonary complications, 1,700 local anæsthesias by five post-operative pulmonary complications. The 5,000 abdominal

operations under general anæsthesia contributed the great majority of lung involvements, largely (65 per cent) broncho-pneumonic in nature. During these years there were about 200 major operations done under a local anæsthetic; four post-operative pulmonary complications are recorded after abdominal operations with this particular type of anæsthesia, and one followed an operation on an extremity. As recorded above, one of these pulmonary accidents, case 49471 was six weeks after operation. Case 48942, an operation on the extremities, is very definitely a case of minor embolism with pleurisy fourteen days after operation. In No. 51039 the rise of temperature, pulse and respiratory rate does not begin till seventy-two hours after operation, the consolidation is unilateral (left side) and the "trachea is drawn over to the left." Such physical findings suggest rather a collapse of the lung than broncho-pneumonia. The diagnosis in the remaining two cases Nos. 51347 and 52051 is "bronchitis", one can only wonder how two hearty adults develop after a local anæsthetic an irritative lesion of this sort; fat embolism might be suggested as the cause in one, a rapidly developing diffuse bronchitis immediately subsequent to a herniotomy, while in the second, a resection of a rib chondroma, fat embolism might account for the early symptoms, and thrombo-embolism for the pain in the chest with the signs of collapse of the lung five to six days later. Gas and oxygen had been used to supplement the local anæsthetic in the latter operation.

It is quite evident that the giving of local anæsthesia may be followed by post-operative pulmonary complications though in a lesser percentage of cases than is seen after a general anæsthetic. Such complications after local anæsthetic will most often be of embolic nature. In considering the cases diagnosed as acute bronchitis or lobular pneumonia and occurring immediately after operation with local anæsthetic, one must naturally assume that either some irritant has arrived into the lung, or that the patient, depressed by the operative procedure, has contracted cold or a lung infection. Fat embolism or multiple emboli to the lungs would fit in well with the first assumption; fat embolism or minor emboli probably account also for many of the acute broncho-pneumonic

accidents seen in association with general anaesthesia.

VIII. Seasonal Incidence of Post-Operative Pulmonary Complications.

Emboli are naturally not dependent upon the change of seasons nor upon questions of prevailing infections; only the lobular pneumonias and the bronchitides show the effect of the winter and spring months upon their incidence. The charted figures of the number and types of pulmonary complications, with the months of their occurrence suggest that the season of acute respiratory infection is the least favourable time for operative procedure. It should not be forgotten that the summer months are often a period of comparative quiet in the surgical wards, but even with this allowance made, the incidence of the acute irritative lesions seems greater between the months of October and May.

	Lobular pneumonias and bronchitis	Minor embolism	Gross embolism
January	3	4	1
February	9	1	1
March	13	1	1
April	16	1	0
May	8	0	0
June	8	0	2
July	3	0	0
August	4	1	0
September	4	3	2
October	4	0	0
November	8	1	3
December	1	0	2

IX Abscess Subsequent to Operation.

As stated above, a large percentage of the cases of post-operative pulmonary abscess occurs subsequent to operation in mouth, nose and throat. Such cases must be of the nature of an aspiration lobular pneumonia with subsequent breaking down of the lung tissue. Some infective foreign body is naturally thought of as a cause of this condition. In none of the five of this type of case (3 teeth extractions, 1 tonsillectomy, 1 sub-mucous resection) was any foreign body detected. The fragments of tartar from dirty teeth with their heavy load of spirilla may be the cause of these lung infections. Tees has reported such a case, and spirillar infections of the respiratory tract have come to be recognized as a definite entity. Even without anaesthesia an infection may occur (Tevinski 28142). Abscess subsequent to gastrostomy for relief of carcinoma of œsophagus might be classed with the inhalation abscess. One such case with signs developing twelve days after operation is on our list. Abscess

of the lung however is a not infrequent complication of carcinoma of the œsophagus that has not come to operation, and to relate an abscess of this nature to a preceding operation is questionable. Two abscesses which followed confinement and surgical abortion suggest that emboli from the uterine and pelvic veins had lodged in the lungs and become infected. There was no femoral thrombosis in these cases. The pelvic veins and uterine sinuses must always be considered as a breeding place of thrombi, infective or non-infective. Secondary infection of the infarcted lung area from aspiration during narcosis is the probable determining process in the abscess formation. Cases of this sort suggest that a similar process was in operation in No. 31337 and 5509, solitary abscesses, one developing with pain shortly after operation, the other developing after three days. The infrequency with which after operation the condition of multiple abscess of the lung occurs is noteworthy; it was never detected clinically. The autopsy records of one case No. 52309, detail multiple abscesses in an acute diffuse lobular pneumonia. If lobular pneumonia subsequent to operation is an aspiration irritative process, the irritant matter must usually lack the organisms which induce lung destruction.

Summary

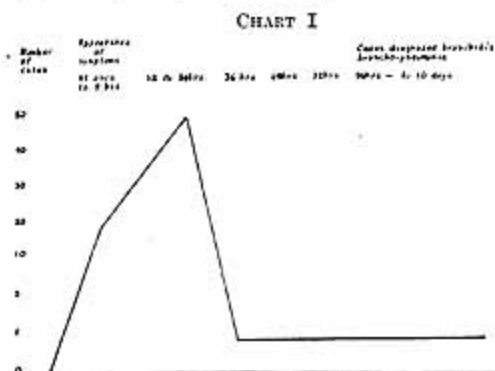
Post-operative pulmonary complications may be looked for after any operation even in perfectly clean cases considered as good risks. They are most usual after operations on the abdomen and the mortality is high. Operations on the extremities, removal of varicose veins, dissections, chipping of bone, all have been followed, however, by acute post-operative pulmonary complications. Thrombo-embolism has seemed the evident cause of these complications in most instances, fat embolism can be suspected in others.

Lobular pneumonia is the lesion most commonly met with, and when the embolic accidents are removed from consideration, it appears that operations done under general anaesthesia are more liable to be followed by this form of pulmonary irritation than those done under a local anaesthesia.

The proper classification (diagnosis) of post-operative lesion is essential to make clear this point. A seasonal incidence is apparent in the lobular pneumonias following operations. The

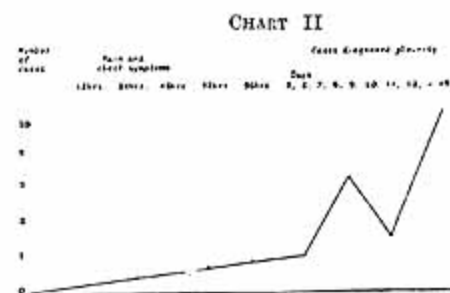
clinical course of post-operative lobular pneumonia differs in some particulars from the usual infectious lobular pneumonia.

There are three groups of post-operative pulmonary complications: first, the early irritative lobular pneumonia, fat embolism, collapse of the lung; lesions of the first seventy-two hours; Chart I; second, the gross embolic, late in onset after



The period in hours after operation in which "irritation lesions" appear.

the operation, usually ending fatally and one of the chief causes of sudden death after operation, Chart III; third, the minor embolic, also occurring late after operation; signalized by a pleural pain and by a less evident severity of their course. Chart II.



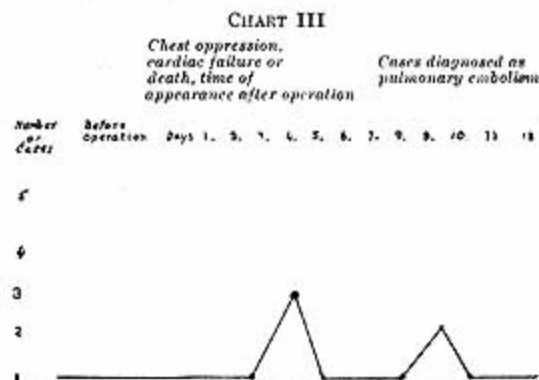
The period after operation, in hours and days, in which acute pleurisy tends to appear.

Empyema and pleural effusions are unusual sequences of broncho-pneumonia or emboli; abscess occurs after post-operative broncho-pneumonia in a somewhat higher percentage than it does in infective broncho-pneumonia, abscess may follow non-fatal embolic infarction; aspiration is the main cause of abscess.

Early fever after operation, late occurring lung symptoms, pleural pain, sudden death, should suggest embolism; a phlebitis in association with such conditions completes a well known picture. Early fever and no lung signs

in absence of any operative complications should excite suspicion of thrombo-phlebitis.

The use of the term "minor embolism" in diagnosis is urged; fever after operation followed by pleurisy with pain is suggestive of this condition, as pleural pain is rarely noted in post-operative broncho-pneumonia or gross embolus. The consolidation found with these pleurisy is a result of infarction. Cases with acute pleural pain usually recover.



Time in hours and days in which gross emboli tend to appear.

Fat embolism and massive collapse of the lung are titles which should be included in any study of post-operative pulmonary complication. A unilateral consolidation should always suggest collapse or infarct. The position of the heart, trachea and diaphragm must always be determined in any case of consolidation, or massive collapse will be overlooked.

Many causes are probably associated with the production of post-operative pulmonary complications. The relation of most abscesses of the lung to inhalation seems clear; minor and gross embolism, one fifth of all post-operative pulmonary complications, come from thrombosis which is more often hidden than visible.

The seasonal incidence of broncho-pneumonia suggests that the shock of the operation, heat, loss, or exposure, may predispose a patient to a prevailing infection; if this be so, there should be a greater incidence of proven lobular pneumonia after the use of local anaesthesia. Minute emboli, thrombi or fat particles from the site of the operation may lodge in the lung in numbers and cause numerous small infarctions; the inhalation of the ether and inhaled secretions added to these infarctions may de-

termine the post-operative broncho-pneumonia. The giving of interstitial saline injections into the chest tissues has been accused of helping to produce post-operative lesions. One feels that the interference with respiration produced by an abdominal incision would materially further the development of congestion and inflammation. Cardiac weakness may play a part. Fat embolism probably explains a certain number of the very acutely developing broncho-pneumonias. Massive collapse should be suspected in unilateral consolidations with severer symptoms.

The classification and the incidence of post-

operative pulmonary lesions can be arranged as follows:

1. Primary lesions: Lobular pneumonia and bronchitis, 63.06 per cent. Minor embolism, 19.08 per cent. Gross embolism, 10.8 per cent. Massive collapse, 4.5 per cent. Fat embolism, .18 per cent. Mediastinitis.

2. Secondary lesions: Abscess and gangrene, infarction, serous effusions, purulent effusions.

No special line of treatment can be urged; embolic lesions cannot be foreseen or prevented in any clinic; the most exacting care in the pre- and post-operative period fails to prevent the occurrence of broncho-pneumonia in a small but fairly fixed percentage of cases.

