

Staff Meeting Bulletin
Hospitals of the » » »
University of Minnesota

Thrombophlebitis
and
Pulmonary Embolism

STAFF MEETING BULLETIN
HOSPITALS OF THE . . .
UNIVERSITY OF MINNESOTA

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Published for the General Staff Meeting each week
during the school year, October to May, inclusive.

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William A. O'Brien, M.D.

I. LAST WEEK

Date: January 6, 1939
Place: Recreation Room
 Powell Hall
Time: 12:12 to 1:20 P.M.
Program: Movie: "That Mothers Might Live"

Announcements
 Laboratory Diagnosis
 of Gonorrhoea

Milan Novak

Discussion

Wesley Spink
 J. L. McKelvey
 W. P. Larson
 Milan Novak

Present: 130

Gertrude Gunn,
 Record Librarian

II. MOVIE

Title: "Catalysis"

Released by: Erpi Corporation.

III. ANNOUNCEMENTS1. SPECIAL FORUM ON SOCIALIZED
 MEDICINE

The staff is cordially
 invited to attend a Special Forum on
 Socialized Medicine, Saturday, January 14,

1939 at 2:30 P.M., St. Paul Hotel.

The Minnesota State Medical Association presents Mr. J. G. Crownhart, secretary of the State Medical Society of Wisconsin, who has just returned from a personal investigation of government medicine in Europe.

Everyone is urged to be present in order that they may obtain information which will help them to intelligently discuss the question. A special invitation has been extended by the officers of the Association to interns and fellows to attend.

2. COORDINATED HEALTH PROGRAM

The Minnesota State Medical Association announces a coordinated medical and public health program for 1939. The cooperating agencies will be local county and district medical societies, Women's Auxiliary, State Board of Health, State Board of Control, Minnesota Medicine, Radio Committee, Weekly News Service, and other public health agencies. The University of Minnesota Medical School is cooperating in the program. The plan is to feature a special problem each month. The subjects are: January, Pneumonia; February, Diseases of Childhood; March, Degenerative Diseases; April, Cancer; May, Obstetrics and Gynecology, (subject to be selected); June, Public Health (State Board of Health); July, University of Minnesota Hospitals and Center for Continuation Study; August, State Board of Control; September, Traumatic Surgery; October, Syphilis and Gonorrhoea; November, Tuberculosis; December, Deficiency Disease and Anemia. An attempt will be made to concentrate interest in both professional and lay education. This program is patterned after similar projects in other states, notably, Indiana.

In connection with "Pneumonia," hundreds of commercial theatres throughout Minnesota are showing the 12-minute pneumonia film for lay instruction.

IV. THROMBOPHLEBITIS and PULMONARY EMBOLISM

Charles B. Craft

I. INTRODUCTION

This report is based on a study of 65 cases of peripheral thrombophlebitis, and 49 fatal cases of pulmonary embolism occurring at the University of Minnesota Hospitals during the period from July 1, 1928 to June 30, 1938.

The term thrombosis is derived from the Greek term "θρομβος." It was used by Hippocrates and Galen for the description of blood coagulation, in particular that which follows hemorrhage into the tissues.

Theories concerning the etiology of thrombosis have varied through the years, depending largely upon the predominating general pathological concepts at the time. Thus, at one time, the physical, and at another time, the clinical hypotheses prevailed with regard to the causes and mechanism of thrombosis.

Thrombosis may be defined as a partial or complete intravital obstruction of a blood vessel by a clot, due to changes in the pre-existent constituents of the blood; namely, (1) the cellular elements, (2) the plasma, or both. In addition trauma, infection, toxins, endothelial damage, and slowing of the blood stream play a most important role. These may precede or be associated with the changes in the constituents of the blood per se.

Thrombophlebitis may be defined as an inflammation of a vein associated with thrombosis. Not infrequently there is evidence of the presence of thrombophlebitis in which no infection is demonstrated.

Thrombosis is most often found in the veins; however, it may also be noted in the arteries, in the heart, and in the capillaries.

Thrombosis and thrombophlebitis occur more commonly in adults, rarely in children,

and somewhat more frequently in females than males.

Thrombophlebitis has been variously stated to occur in from one to four per cent of all post operative procedures, especially in lower abdominal operations, exhibiting a marked predilection for the left lower limb. Thrombosis usually, and less frequently thrombophlebitis, are the precursors of the dreaded fatal pulmonary embolism, most often, unfortunately, in those very cases where there is the least clinical evidence of a thrombus to warn of the impending disaster. In addition there is always the danger of dislodgment of smaller fragments of the thrombus, with resultant pulmonary infarction; which, although not necessarily fatal does materially lengthen convalescence.

Thrombosis if accompanied by signs of inflammation of the veins of the lower extremities per se, may be the source of much pain and disability, as well as lengthening the convalescence.

II. ETIOLOGY OF THROMBOSIS

The theory of Aschoff is probably the best. He believes there are four main factors in the production of thrombosis:

1. Changes in the blood flow (slowing and eddy formation)
2. Changes in the blood plasma (diminished or increased coagulability)
3. Changes in the blood elements (increased or decreased power of agglutination)
4. Changes in the vessel wall (endothelial damage)

It is his contention that there is not a "single cause" of thrombosis; but several, sometimes one factor, sometimes another playing the principal role.

III. PERIPHERAL THROMBOPHLEBITIS

A. Analysis of Cases (General)

An analysis of the 65 cases is presented in Tables I, II, III, IV, and

V. Table I shows the sex, age distribution by decades, and percentage of cases by decades.

TABLE I

| MALES | | | FEMALES | | |
|--------|----------------------------|-------------------|---------|----------------------------|-------------------|
| Decade | No. of Cases of thrombosis | Per Cent of cases | Decade | No. of Cases of thrombosis | Per Cent of cases |
| 1 | 0 | 0 | 1 | 0 | 0 |
| 2 | 1 | 1.54 | 2 | 0 | 0 |
| 3 | 4 | 6.15 | 3 | 2 | 3.08 |
| 4 | 5 | 7.69 | 4 | 5 | 7.69 |
| 5 | 4 | 6.15 | 5 | 4 | 6.15 |
| 6 | 15 | 23.08 | 6 | 5 | 7.69 |
| 7 | 5 | 7.69 | 7 | 7 | 10.82 |
| 8 | 6 | 9.07 | 8 | 1 | 1.54 |
| 9 | 0 | 0 | 9 | 1 | 1.54 |
| Total | 40 | 61.5% | | 25 | 38.5% |

It is to be noted in Table I that thrombophlebitis occurred in the male in 40 or 61.5% of the cases, and in 25 or 38.5% in females. It will also be noted that the largest percentage of the cases occurred in the 4th, 5th, 6th, and 7th decades for both males and females. The greatest number of cases were

in the 6th decade, 20 or 30.8%. The higher percentage in the male is not in accord with the figures reported in the literature.

No plausible explanation is offered other than the fact that only a relatively small percentage of the total number of patients with thrombophlebitis were studied. The series is too small to be considered of definite incidence value.

B. Analysis of Postoperative Cases

Table II shows for the postoperative cases, the sex, site of operation, and

the site of thrombosis as well as the respective percentages of occurrence.

TABLE II

| MALES | | | | | |
|-------------------|--------------|-------------------|--------------------|--------------|-------------------|
| Site of Operation | No. of Cases | Per Cent of Cases | Site of Thrombosis | No. of Cases | Per Cent of Cases |
| Head-Neck | 0 | 0.0 | Left Femoral | 12 | 30.77 |
| Thorax | 0 | 0.0 | Right Femoral | 2 | 5.13 |
| Upper Abd. | 9 | 23.07 | R. & L. Femoral | 1 | 2.56 |
| Lower Abd. | 8 | 20.51 | Popliteal | 2 | 5.14 |
| Transurethral | 2 | 5.13 | Miscellaneous | 4 | 10.26 |
| Lower Ext. | 1 | 2.56 | Group = Short | | |
| Spinal Col. | 1 | 2.56 | Long Saphenous | | |
| | | | Superficial | | |
| | | | Leg Veins | | |
| Total | 21 | 53.83 | | 21 | 53.86 |

TABLE II (Cont.)

| FEMALES | | | | | |
|-------------------|--------------|-------------------|--------------------|--------------|-------------------|
| Site of Operation | No. of Cases | Per Cent of Cases | Site of Thrombosis | No. of Cases | Per Cent of Cases |
| Head-Neck | 1 | 2.56 | Left Femoral | 8 | 20.51 |
| Thorax | 3 | 7.69 | Right Femoral | 3 | 7.69 |
| Upper Abd. | 5 | 12.82 | R. & L. Femoral | 0 | 0.0 |
| Lower Abd. | 5 | 12.82 | Popliteal | 2 | 5.14 |
| ----- | | | Miscellaneous | 5 | 12.82 |
| | | | Group: | | |
| Lower Ext. | 4 | 10.26 | | | |
| Spinal Col. | 0 | 0.00 | | | |
| Total | 18 | 46.15 | | 18 | 46.16 |

Postoperative thrombophlebitis is said to occur somewhat more frequently in the female, exhibiting a marked predilection for the left lower extremity. From these figures it is seen that thrombophlebitis occurred more frequently in the male, and if the total male and female admissions during the ten year period are considered it is found that the percentage of incidence for the male is 0.113% and for the female 0.065% which is even more significant. As a possible explanation, it may be that the average age of the male patients admitted during that time was considerably higher than that of the female patients, due possibly, to a partial deleting of the younger population of the state by the World War. In addition, the

economic status of the country during the past decade may have played a part in causing more of the older age group to seek hospitalization.

The average age of the total number of males studied was 55.25 years, whereas for the females, the average age was 51.96 years of age.

The left lower extremity was the site of the thrombophlebitis in over 50% of the cases, which is the usual finding. The right femoral vein was the site of the thrombophlebitis in 12.82% of the postoperative cases, both femorals in 2.55%, the popliteals in 10.28%, and the miscellaneous group in 23.08%. The miscellaneous group consisted of long and short saphenous, and superficial leg veins.

C. Analysis of Cases with regards to Total Admissions

TABLE III

| Year | Hospital Admissions | | Per Cent Total of male adm. | Year | Thrombosis | | Yearly % Occurrence | |
|---------|---------------------|--------|-----------------------------|---------|------------|--------|---------------------|--------|
| | Male | Female | | | Male | Female | Male | Female |
| 1928-29 | 1863 | 2473 | 45.27 | 1928-29 | 4 | 1 | 6.15 | 1.53 |
| 1929-30 | 2420 | 2933 | 45.21 | 1929-30 | 4 | 3 | 6.15 | 4.61 |
| 1930-31 | 3026 | 3411 | 47.00 | 1930-31 | 6 | 3 | 9.07 | 4.61 |
| 1931-32 | 3248 | 3520 | 47.99 | 1931-32 | 5 | 4 | 7.69 | 6.15 |
| 1932-33 | 3650 | 3957 | 47.98 | 1932-33 | 6 | 3 | 9.07 | 4.61 |
| 1933-34 | 3634 | 3939 | 47.99 | 1933-34 | 2 | 4 | 3.07 | 6.15 |
| 1934-35 | 4255 | 4605 | 48.12 | 1934-35 | 4 | 3 | 6.15 | 4.61 |
| 1935-36 | 4068 | 4461 | 47.70 | 1935-36 | 1 | 2 | 1.53 | 3.07 |
| 1936-37 | 4684 | 4532 | 50.82 | 1936-37 | 6 | 1 | 9.07 | 1.53 |
| 1937-38 | 4296 | 4889 | 46.88 | 1937-38 | 2 | 1 | 3.07 | 1.53 |

It is to be noted in Table III that there has been an increase in the percentage of male admissions to the total admissions from a low of 45.21 in 1929-30 to a high of 50.82 in 1936-37, a difference of 5.61 percent. The average percentage increase for the ten-year period being 2.29.

From Table III it may also be noted that the yearly percentage occurrence of thrombophlebitis in the male has shown a fairly constant rise, with fluctuations here and there, along with the increase in the percentage of male admissions to the total number of admissions.

D. Operative Site, Analysis of Cases

Table IV is a presentation of the total number of operative procedures for

the various sites, and the percentage of incidence of thrombophlebitis following operative procedures at these sites.

TABLE IV

| Site of Operation | No. of Operations | No. of Cases of Thrombosis | Per Cent of Incidence |
|-------------------|-------------------|----------------------------|-----------------------|
| Head-Neck | 2,258 | 1 | 0.044 |
| Thorax | 1,388 | 3 | 0.216 |
| Upper Abd. | 1,981 | 14 | 0.706 |
| Lower Abd. | 6,419 | 13 | 0.203 |
| Transurethral | 604 | 2 | 0.331 |
| Lower Ext. | 1,702 | 5 | 0.293 |
| Spinal Col. | 265 | 1 | 0.377 |
| Total | 14,617 | 39 | Av. = .266 |

Thrombophlebitis occurs more frequently after abdominal operative procedures, the reported figures varying from one-half to four per cent. In this series 8,390 abdominal operative procedures showed an incidence of 0.46 per cent. The various operative procedures, and the number of cases, which were followed by thrombophlebitis are listed as follows: Cholecystectomy 6 cases, hernioplasty 5 cases, amputation lower extremity 4 cases,

appendectomy 3 cases, exploratory abdominal laparotomy 3 cases, gastroenterotomy, cystostomy, hemorrhoidectomy, transurethral resection, and radical mastectomy 2 cases each, and following proctectomy, laminectomy, splenectomy, posterior excision of rectum, drainage of empyema cavity, fracture of lower extremity, incision and drainage of toe, and biopsy of cervical node, is one case each.

E. Time of Onset, and General Status of Patients

Table V presents the time in weeks, of onset of symptoms, postoperatively, in the 27 cases in which the record con-

tained the desired information. Table V also presents data relative to nutrition, presence of heart disease, carcinoma, and varicosities in total group of patients studied.

TABLE V

| Time of Onset of Thrombosis Postoperatively - 27 cases | | | | | | | | General Status of Entire Group of Patients | | | | | | | |
|--|----|---------|----|---------|----|------------------|----|--|----|-----------------------|------|--------------------------|------|-------------------------|----|
| 1st wk. | | 2nd wk. | | 3rd wk. | | 4th wk. or later | | Presence of Ht. Disease | | Presence of Carcinoma | | Presence of Varicosities | | Well-nourished patients | |
| | % | | % | | % | | % | | % | | % | | % | | % |
| 6 | 22 | 13 | 48 | 4 | 15 | 4 | 15 | 26 | 40 | 10 | 15.4 | 16 | 24.6 | 54 | 83 |

The onset of thrombophlebitis post-operatively, occurs most frequently during the latter part of the first week, or in the middle of the second week, and relatively rarely after the fourth week. In this series 70% of the cases occurred within the first two weeks.

Even though the average age for the entire group of patients studied was 57.1 years of age, the per cent occurrence of heart disease, carcinoma, and varicosities in association with thrombophlebitis

was somewhat lower than is usually reported in the literature. The reported figures vary from 40-80%, especially with reference to heart disease and carcinoma.

The fact that 83% of the patients were well developed and well nourished reveals the fact that cachexia and its attendant ill effects upon the body in general were absent; thereby dispelling the idea that thrombosis is particularly a disease of the infirm, emaciated, and poorly nourished.

IV. FATAL PULMONARY EMBOLISM

A. Analysis of Cases (General)

The results of the study of the 49 cases of fatal pulmonary embolism are presented in Tables I, II, III, IV, V, and VI.

Table I presents the sex, age distribution and incidence of fatal pulmonary embolism by decades.

TABLE I

| MALE | | | FEMALE | | |
|--------|--------------|-----------------------|--------|--------------|-----------------------|
| Decade | No. of Cases | Per Cent of Incidence | Decade | No. of Cases | Per Cent of Incidence |
| 1 | 0 | 0.00 | 1 | 0 | 0.00 |
| 2 | 2 | 4.08 | 2 | 1 | 2.04 |
| 3 | 3 | 6.12 | 3 | 2 | 4.08 |
| 4 | 2 | 4.08 | 4 | 1 | 2.04 |
| 5 | 3 | 6.12 | 5 | 3 | 6.12 |
| 6 | 5 | 10.20 | 6 | 2 | 4.08 |
| 7 | 7 | 14.28 | 7 | 5 | 10.20 |
| 8 | 7 | 14.28 | 8 | 4 | 8.16 |
| 9 | 1 | 2.04 | 9 | 1 | 2.04 |
| Total | 30 | 61.23 | Total | 19 | 38.77 |

In this series fatal pulmonary embolism occurred somewhat more frequently in the male than in the female. Sex apparently plays no role in pulmonary embolism. Some authors report a higher per cent of males, others a higher per cent of females; in general, however, there is no constant significant difference. Pulmonary embolism following trauma is decidedly more common in females, a fact pointed out by McCartney.

The average age of the patients was 55.3 years of age. Most writers report the

highest incidence of pulmonary embolism in the 5th, 6th, 7th, and 8th decades.

No doubt age plays an important role in pulmonary embolism, not age in itself, but the accompaniments of age; namely, cardiac disease, with its effect on circulation, decreased muscular activity, and impaired muscle tone, obesity, the presence of debilitating and wasting diseases, with lowered general systemic resistance, and inability to combat disease.

B. Incidence of Pulmonary Embolism

Table II shows the percentage of incidence of fatal pulmonary embolism, in post-mortem examinations, number of

deaths, total number of admissions, and male and female admissions during the 10 year period of study.

TABLE II

Incidence of Pulmonary Embolism

| | | | |
|--------------------|--------|---------------------|--------|
| 2,781 P.M. Exam. | 1.76% | 35,144 Male Adms. | 0.139% |
| 3,971 Deaths | 1.23% | 38,320 Female Adms. | 0.127% |
| 73,464 Total Adms. | 0.066% | P.M. Exams. 70.03% | |

From Table II it is noted that the percentage of pulmonary embolism to post-mortem examination is 1.76 which compares favorably with the figures reported in the literature. An incidence of 1.67% is reported by Kirshbaum and Shively covering 36,009 cases, including 10,650 cases of their own. The percentage of pulmonary embolism to deaths is 1.23%, a figure slightly lower than those usually reported, the reported figures varying from 2 to 10%.

911,315 patient admissions in 12 London Hospitals from 1925-1934.

It is also to be noted in Table II during the 10-year period of time 70% of the deaths were followed by post-mortem examinations.

Table III shows the percentage of pulmonary embolism in the surgical, medical, and gynecological cases, as well as sites and number of operative procedures with their respective percentage of occurrences.

The incidence of pulmonary embolism to total admissions was found to be 0.066%. Pilcher reports an incidence of .079% for

C. Operated and Non-Operated Pulmonary Embolism

TABLE III

| Type of Cases | No. of Cases | Per Cent P.Emb. | Site of Operation | No. of Cases | No. of Operations | Per Cent P.Emb. |
|---------------|--------------|-----------------|-------------------|--------------|-------------------|-----------------|
| Surgical | 21 | 42.68 | Thorax | 4 | 1,388 | 0.288 |
| Medical | 25 | 51.2 | Upper Abd. | 4 | 1,981 | 0.201 |
| Gynecological | 3 | 6.12 | Lower Abd. | 8 | 6,419 | 0.124 |
| Total | 49 | 100.0 | Lower Ext. | 5 | 1,702 | 0.284 |

Average - 0.182

Pulmonary embolism can and does follow operative procedures anywhere in the body, however, the complication most often follows operative procedures upon the abdomen, and pelvis. Operations upon the prostate (abdominal approach), biliary and intestinal tracts are most often followed by pulmonary embolism.

occurrence (0.228) for the various post-operative groups was found to be the thorax, followed closely by the lower extremities (0.284%). The average percentage of occurrence for the entire group being 0.182%.

Naegli reports 21 postoperative cases of fatal pulmonary embolism in 15,406 operations, an incidence of 0.14%.

In this series the highest per cent

Lockhart-Mummery reports 9 cases in 5,406, and 12 cases in 11,804 operations with the respective percentages of incidence of 0.166 and 0.101.

De Quervain reports 5 cases of pulmonary embolism following 1,333 operations upon the thorax, and 16 cases of pulmonary embolism following 7,996 operations upon the lower extremities. The per cent of incidence being therefore 0.37 for the thorax, and 0.20 for the lower extremities.

In general, pulmonary embolism is usually more frequent in the surgical post-operative patient, than in the medical patient; however, in this series the medical group comprised 51.2% of the patients, the surgical group 42.68% and the gynecological group 6.12%.

Kirshbaum and Shively report 56% of their cases occurring postoperatively and 44% were non-operated cases.

The operative procedures which were followed by fatal pulmonary embolism are listed as follows:

D. Surgical Cases

| <u>Operation</u> | <u>No. Cases</u> |
|--|------------------|
| Excision Carcinoma of Sigmoid | 2 |
| Cholecystectomy | 2 |
| Closed Drainage Empyema | 2 |
| Fracture lower extremity | 2 |
| Hernioplasty | 2 |
| (1 ventral | |
| (1 bilateral inguinal | |
| Amputation lower extremity | 1 |
| Appendectomy | 1 |
| Supra pubic cystostomy | 1 |
| Transurethral resection and supra pubic cystostomy | 1 |
| Supra pubic prostatectomy | 1 |
| Transurethral resection | 1 |
| Revision of Colostomy | 1 |
| Chondrocostectomy | 1 |
| Incision and Drainage of breast abscess | 1 |
| Debridement and skin graft lower extremity | 1 |
| Abdominal paracentesis | 1 |
| Embolectomy lower extremity | 1 |

The gynecological operative procedures which were followed by fatal pulmonary embolism are:

| <u>Operation</u> | <u>No. Cases</u> |
|---|------------------|
| Hysterectomy and right salpingophorectomy | 1 |
| Vulvectomy | 1 |
| Repair of cystocele and rectocele | 1 |

The total number of gynecological operative procedures carried out during the 10-year study period were not determined, therefore no figures relative to the incidence of pulmonary embolism following these procedures are given.

Most authors report an incidence of fatal pulmonary embolism of from half of one per cent to two per cent following prostatectomy. No figures relative to the incidence of fatal pulmonary embolism following transurethral resection were found in the literature covered; however, in this series pulmonary embolism followed transurethral resection in one case, and suprapubic prostatectomy in one case.

Since 1930 a total of 604 transurethral resections have been performed, an incidence therefore of 0.165%.

E. Autopsy Findings

Table IV shows the site of primary thrombosis, and the site or location of the fatal embolus.

TABLE IV

| Site of Primary Thrombosis | | | | | | | | | | Site of Embolus | | | | |
|----------------------------|-----|----------|----------|--------------------------|----|-------|------|-------------|----------------|-----------------|--------------------|----------|----------|------------|
| Femoral | | Iliacs | | Ovarian & Peri-Prostatic | | Heart | | Total Found | Per Cent Found | Not Found | Per Cent Not Found | Rt. Lung | Lt. Lung | Both Lungs |
| Rt. | Lt. | Internal | External | R. | L. | R. | L. | | | | | | | |
| 9 | 8 | 6 | 2 | 8 | 1 | 34 | 69.4 | 15 | 30.6 | 14 | 10 | 25 | | |

The most frequent sites of primary thrombosis are the pelvic veins (common, internal, and external iliacs), femoral veins, and peri-prostatic plexus. Sometimes the primary site may be within the operative field.

The primary site was found in 69.4% of

the cases and the pelvic, femoral, ovarian, and peri-prostatic plexus veins accounted for twenty-five, or 73.5% of the cases herein reported. One of the cases had a patent interventricular septum and the site of primary thrombosis was in the left heart.

F. Symptoms and General Status of Patients

Table V presents the data relative to the time of onset in weeks of the post-

operative pulmonary embolus, and the general status of the patient.

TABLE V

| Time of onset of symptoms | | | | General Status of the Patient | | | | | | | | | | |
|---------------------------|----------|----------|----------|-------------------------------|------|-----------------|------|--------------------------|------|-----------------|------|-------------|------|------|
| 1st Week | 2nd week | 3rd week | 4th Week | Presence of Ht. Disease | | Presence of Ca. | | Presence of Varicosities | | Temp. & Infect. | | Nourishment | | |
| | | | | | % | | % | | % | | % | Well | Fair | Poor |
| 6 | 5 | 6 | 4 | 33 | 67.3 | 12 | 24.5 | 5 | 10.3 | 38 | 77.7 | 29 | 4 | 15 |

Postoperatively pulmonary embolism usually occurs during the first two weeks and is relatively rare occurrence after one month.

Most often the patient is up and about and is ready for discharge, the post-operative course having been uneventful, when suddenly the patient is seized with a severe sub-sternal pain, and is dyspnoeic, becomes cyanotic, often apprehensive and expires within a few minutes. The majority of cases usually expire within 15 minutes or less. This type of death is usually associated with an embolus sufficiently large to occlude the common pulmonary artery. In other instances death may not ensue for hours or even days, death usually being due to a small embolus or showers of emboli.

An acute onset is probably the most

constant symptom of fatal pulmonary embolism, and a severe circulatory disturbance is one of the most constant symptoms.

The onset of the symptoms and signs of pulmonary embolism may or may not follow motion or exertion by the patient. Not infrequently the onset is noted during rest or sleep.

Pulmonary embolism is not necessarily a disease or complication of the hospital patient, or an obviously ill patient, as is manifested by the fact that numerous cases of fatal pulmonary embolism are brought into the hospital dead. These patients had been up and about carrying on their usual routine duties, and were suddenly stricken with a fatal pulmonary embolus as proven by post-mortem examination.

Both lungs were found to be the site of embolus in 25 or 51.02% of the cases, the right lung in 28.59% of the cases, and the left lung in 20.4% of the cases. These findings are in keeping with those reported in the literature.

There was evidence of a temperature rise and infection in 77.7% of the cases.

Cardiac disease was present in 67.3% of the cases. The presence of cardiac disease usually doubles the incidence of pulmonary embolism.

Kirshbaum and Shively report 64.3% of their cases as showing evidence of cardiac disease.

Varicosities were present in only 10.3% of the cases; however, the low percentage reported is no doubt due to the incompleteness of the record on this

point; namely, failure to mention the presence or absence of varicosities in over one half of the cases.

There was evidence of carcinoma in 24.5% of the cases. Although the percentage of patients with carcinoma is not strikingly high, the deleterious effects of the carcinoma may have played a part in the initiation of the primary thrombosis.

In general, the physical status of the patients with regards to development and nourishment was fairly good, 59.18% were well nourished, 30.61% poorly nourished, 8.16% fairly well nourished, and in 2.05% the status could not be determined.

Table VI presents information with regard to the duration of life after the onset of symptoms, and the time of day or night when the embolus occurred in the postoperative group.

TABLE VI

| Duration of life after onset of symptoms. | | | | | | | | Time of onset of Embolus symptoms | |
|---|--------|--------|------|------|-------|--------|---------------|-----------------------------------|-------------------------|
| 0-15" | 15-30" | 30-60" | 1-3' | 3-6' | 6-12' | 12-24' | 24' or longer | Day 8 A.M.- 8 P.M. | Night 8 P.M.- 8 A.M. |
| 7 | 7 | 9 | 1 | 1 | 4 | 1 | 5 | 16 | 8 |

Information relative to the duration of life after the onset of the acute attack was available in only 35 of the cases.

Twenty-three, or 65.71% of the cases were dead within 1 hour, and 65.66% of the deaths for the postoperative group occurred during the day. Five of the 24 cases occurred between 7 P.M. - 8 P.M. Nygaard reporting on 250 cases found the highest incidence to be during the day (67.2%); however, one or more attacks occurred during each of the 24 hours.

A majority of the patients with an acute attack of pulmonary embolism are dead within 15 minutes, and 80 to 90% are dead within one hour.

It is obvious, therefore, that any surgeon planning to deal with pulmonary

embolism by surgical measures must be available at all times, day or night, for not only is the element of time short but the accident may occur at any time.

The correct clinical diagnosis prior to post-mortem examination was made in 38.77% of the cases. The low percentage of correct clinical diagnosis, as determined from information on the chart, may be explained by the fact that in a large majority of the cases, no note relative to the death and cause of death was made by responsible parties.

V. DISCUSSION

Postoperative thrombophlebitis and pulmonary embolism are clinical entities which are of profound interest and sig-

nificance, especially to the surgeon. Fear on the one hand of sudden death, due to pulmonary embolism, and on the other, to prolonged convalescence, due to postoperative thrombosis and pulmonary infarction, has prompted numerous investigations and studies as to the cause, and possible prevention of thrombosis.

In this clinic, investigative work is being carried out by members of the surgical staff, on venous circulation time, venous pressure, and tissue pressure both pre- and post-operatively; as well as the effects of position, exercise and abdominal distention on the venous circulation, the venous and tissue pressures.

In a study of 130 cases, the post-operative circulation time is found to be decreased an average of 2 seconds in the upper extremity and 3 seconds in the lower extremities, when compared with preoperative rates. The postoperative determinations were made within 24 hours after operation, and the decrease in rate is thought to be due to the effect of the increased temperature and respiratory rate on the pulse rate, causing an increase in the pulse rate with resultant decrease in venous circulation time.

The effect of position on the venous circulation has been found to be a most important one.

Typically it was found in 6 cases that with the patient in the horizontal position the venous circulation time was 35 seconds, with the patient in the Trendelenburg position the circulation time was decreased to 20 seconds, and with the patient in the reverse Trendelenburg position the circulation time was increased to 42 seconds.

In 4 cases the effect of changing the position of the lower extremity was studied. With the leg level the average venous circulation time was 45.5 seconds, with the leg elevated 20 seconds, and with the leg dependent 53.3 seconds.

In 6 cases the venous circulation time was studied with the patient in the dor-

sal decubitus and sitting position. The circulation time with the patients in dorsal decubitus were within normal limits; however, with the patient in the sitting position, no response was noted in any of the cases. By "no response" it is meant that there was no stimulation of the carotid body sinus by the injected sodium cyanide, which is the agent used in testing the circulation time.

The presence of abdominal distention has been found in 2 clinical cases to increase the venous circulation time, and in the experimental animal abdominal distention, which, if severe or acute, not only prolongs the circulation time, but the venous return finally ceases before the death of the animal.

Active motion of the foot and toes has been found to decrease the circulation time in 2 clinical cases.

Obviously, these changes noted in the venous circulation time are significant, and the part played by position, exercise and abdominal distention in thrombosis, especially postoperative thrombosis cannot be denied.

Even though more than one factor is necessary in the production of thrombosis, the more or less automatic addition of increased circulation time post-operatively, adds greatly to the probability of thrombosis. Especially is this true if the patient's position is not changed frequently postoperatively, if the semi-erect or Fowler's position is employed, and abdominal distention to any degree allowed to take place.

It is essential, therefore, that these practices be studiously avoided.

VI. PROPHYLACTIC TREATMENT

In an attempt to prevent postoperative thrombosis and pulmonary embolism, all of the factors important in the formation of thrombosis should be energetically combatted.

Of all of the prophylactic measures employed, that of the prevention of venous stasis is probably the most important. Frequent active motion on the part of the patient is the best measure to prevent postoperative venous stasis. Active motion on the part of the patient is superior to passive motion. At this hospital, unless there is some strict contraindication, directly after operation every patient is urged to move his arms and legs freely "a thousand times daily," an admonition which is pressed on him until he becomes ambulant.

Frequent postoperative change of position is also employed, that is, when it is known that shock will not occur and the patient has fully recovered from the effects of the anesthetic. The patient's position is changed every two hours, night and day when awake, by attendants in the following manner; first he lies for two hours on his back, then two hours on one side, then two hours on his back again, then two hours on the other side, and so on, spending half of the time on his back, and the other half divided between the right and left sides. Other procedures which might be employed are elevation of the foot of the bed once or twice daily for variable periods of time. Except in the very rare instance is the Fowler or semi-Fowler position to be employed. Its use in this clinic is rarely if ever employed.

In order to overcome postoperative distention due to impaired motility of the gut, associated with intraperitoneal operations, free use of the duodenal tube both pre- and post-operatively is carried out.

The effects of the impaired mobility of the diaphragm following especially upper abdominal operations, is best overcome by having the patient cough two or three times following a deep inspiration; while the nurse compresses the chest and abdomen, thus protecting the incision with the avoidance of pain. This maneuver should be repeated three or four times a day.

In addition adequate amounts of fluid either intravenously, sub-cutaneously,

or by proctoclysis are employed. Not infrequently blood transfusions are used to keep the blood pressure at a satisfactory level, thereby improving circulation. A satisfactory fluid intake is important in order to obviate dehydration and changes in the blood elements.

Firor and others are of the opinion that continuous intravenous fluid injections cause changes in the vessels and promote thrombosis. Miller and Rogers do not agree with Firor's contention that vessels are injured by intravenous injection and tend to become thrombosed. If what he says is true, intravenous injection of arsenical preparations in the treatment of syphilis should be followed by thrombosis, and this does not occur.

Fluids and food by mouth are given as early as tolerated postoperatively, for it is known that a bolus of food going through the pylorus stimulates peristalsis, thus carrying off gas as well as preventing fermentation. The patients are allowed to be out of bed as soon as possible in order to further improve the circulation.

To mention a few of the procedures used elsewhere in the prophylaxis of postoperative thrombophlebitis, would be: the use of leeches, applying them around blood vessels between the 5th and 9th days postoperatively.

Elaborate exercising devices, consisting of bicycle pedals mounted on a board base.

The injection of heparin into the muscles around the operative site.

The use of CO₂ and O₂ inhalations for 3 to 5 minutes every 2 hours for the first 24-48 hours postoperatively.

The use of desiccated thyroid grs. 2 t.i.d. from the 2nd to 10th postoperative day.

The practices which are to be avoided are Fowler's position, knee pillow, tight abdominal dressing, and the use

of the Gatch bed.

VI. TREATMENT OF THROMBOPHLEBITIS AND PULMONARY EMBOLISM

Once a diagnosis of thrombophlebitis is established, immediate treatment is instituted; namely, the enforcing of absolute bed rest, elevation of the part, application of moist, hot dressings, and in some cases the application of an ace bandage to the involved member. General supportive treatment, a satisfactory fluid intake and urine output maintained, and treatment of any local or distant foci of infection as indicated.

Ochsner and others advocate the placing of leeches around the site of thrombophlebitis, reporting very satisfactory results.

Leriche advocates resection of the first lumbar sympathetic ganglion in the treatment of acute phlebitis, because such a procedure not only relieves the venospasm, and arteriospasm, which he believes to be present, but it also relieves pain, edema, and decreases the extent of coagulation. He feels that the venospasm is constant in these cases, causes most of the pain and favors the extent of coagulation.

During the past few months at this hospital a new and very encouraging type of treatment of thrombosis has been used by Dr. John R. Paine. The method consists of the application of intermittent venous occlusion, by means of a cuff applied around the thigh. Twelve patients have been so treated to date, with marked subjective improvement in every case, and a decrease in the size of the limb in some of the cases.

The active treatment of pulmonary embolism is by surgical intervention; namely, the performance of the Trendelenburg operation. Up until 1932 the collected cases from the literature revealed that the operation had been performed in 132 cases, with a recovery in 9 cases, a mortality rate of 93.2%.

Up until 1935 there had been 21 suc-

cessful Trendelenburg operations, all of these were performed in Europe. No successful Trendelenburg operation had been performed until 1935 in the United States.

The fact that so many patients do not live long enough to be subjected to such an operative procedure, plus the difficulty in diagnosis and prognosis along with the technical difficulties of the operation per se, paints a very pessimistic picture of the possibility of embolectomy for massive pulmonary emboli.

The real practical treatment of pulmonary embolism is the vigorous prophylactic treatment of thrombosis.

VII. SUMMARY AND CONCLUSIONS

1. Sixty-five cases of peripheral thrombophlebitis and 49 cases of fatal pulmonary embolism occurring during the period July 1, 1928 - June 30, 1938, are reported.
2. The incidence of postoperative thrombophlebitis was 0.266%.
3. The incidence of postoperative thrombophlebitis following 8,390 abdominal operative procedures was 0.46%.
4. The incidence of fatal pulmonary embolism in 2,781 postmortem examinations was 1.76%.
5. The incidence of fatal pulmonary embolism following 11,490 operative procedures was 0.182%.
6. The incidence of fatal pulmonary embolism in 73,464 hospital admissions was 0.066%.
7. The results of certain investigations on circulation time, as carried out in this clinic are presented and discussed. These results demonstrate the effects of exercise, position of patient, and abdominal distention on circulation time.
8. The prophylactic measures used in the

prevention of thrombosis, thrombophlebitis, and pulmonary embolism as used in this clinic are presented.

These comprise measures to encourage, in general, active motion on the part of the patient, free use of the duodenal tube, changing of the patient's position every two hours while awake, and an adequate intake and output, as well as general supportive treatment as indicated.

9. Two relatively new types of treatment of thrombophlebitis are presented:

- a. Resection of first lumbar sympathetic ganglion (Leriche).
- b. Application of intermittent venous occlusion, by means of a cuff applied to the thigh. (Paine)

10. The results of the treatment of pulmonary embolism by the Trendelenburg operation up to 1935 are presented and discussed.

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V. "100 YEARS"

Saturday, January 14, 1939, is the 100th anniversary of the birth of George Henry Christian, founder of the Citizens' Aid Society, the organization which sponsors the publication of the Staff Meeting Bulletin of the Hospitals of the University of Minnesota. Mr. Christian's birthday will be appropriately celebrated with a dinner and program at the Citizens' Club, one of his chief benefactions. Born and educated in the South, he came to Chicago at the age of 15 (after a short stay in New York State). Instead of attending college, he secured a position with a wholesale flour firm, where he learned the business from the bottom up. At 28, feeling that he had mastered the fundamentals of flour manufacture and distribution, he came to Minneapolis to open his own mill. On his arrival he formed a partnership with Cadwallader C. Washburn under the firm name of George H. Christian and Company. They operated one of the largest mills in Minneapolis with a daily output of 600 barrels of flour. Prior to the opening of the plant, experienced millers of their day scoffed at the possibility of producing that much flour a day, but Mr. Christian silenced his critics by producing the 600 barrels without difficulty. During his lifetime, he is credited with discovering and developing most of the important mechanical improvements in flour manufacture. After a long and successful career, he retired with an accumulated wealth which he did not consider his own. He felt that he was only the custodian of this fortune, and with his good wife, began to plan for its disposal. In his earlier years, his travel was limited to business pursuits. After his retirement, he devoted his time to cultural travel, reading, and study, which he did with the same enthusiasm and energy that he had applied to the manufacture and sale of flour. As Mr. Christian devoted his time to business, his wife was correspondingly active in promoting the welfare of their fellow men. In this program he was as active a participant as time would permit, but on his retirement, he became intensely interested in social betterment. Tragedy, which came to his home in the form of tuberculosis and cancer, was a strong factor in helping to develop his program.

One of his first projects was the erection of Thomas Hospital, now a part of Fairview Hospital, but originally devoted to the care of the tuberculous. In 1913 he gave the funds for the Citizens' Club in South Minneapolis, said to be one of the finest units of its kind in the country. In 1916, he formed the Citizens' Aid Society, to which he left the bulk of his fortune. His death occurred January 19, 1918, and, since that time, his good works have been continued by the Citizens' Aid Society Board, consisting of Mrs. George Chase Christian, W. P. Christian, Franklin Crosby, and Chas. M. Case. Tuberculosis, cancer, social welfare, music, and the arts have continued to be the main objects of their benefactions. Glen Lake Sanatorium has received the Children's Pavilion, 1922; permanent Children's Camp, 1925; Occupational Therapy and Vocational Building, 1931; representing a total outlay of \$500,000 for tuberculosis. The University of Minnesota was given the Cancer Institute in 1925; and the social agencies of Minneapolis sponsored by the Community Fund, were given the Citizens' Aid Building in 1927 at a cost of \$360,000. Unknown to everyone except the Board and the recipients have come innumerable gifts for social and medical welfare. The Board has given to the University several additions to the equipment of the Cancer Institute, and, for the past ten years, has supplied an annual grant for education and assistance in the clinical departments, medical social work and research. It is from this fund that the money for publishing the Staff Meeting Bulletin is obtained. At the dinner Saturday night, the chief emphasis will be on the development and accomplishments of the Citizens' Club. During his lifetime, Mr. Christian would not have permitted such a demonstration. On the 100th anniversary of his birth, his friends are observing the event. The Citizens' Club has played a large part in the creation of good citizenship in Minneapolis by helping hundreds of boys of all creeds and social status. We of the University of Minnesota salute the memory of George Henry Christian and to his descendants express our appreciation for his good works and charitable deeds.