THE FILAMENT-NONFILAMENT COUNT

ITS DIAGNOSTIC AND PROGNOSTIC VALUE

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Since the time of Ehrlich's epoch-making discovery of a satisfactory method of staining the white blood cells, definite and steady advances have been made in the methods and interpretations of total white blood counts and differential smears. As is well known, the white blood cells were first divided into three types — granulocytes, lymphocytes and large mononuclears. The granulocytes have been further divided into polymorphonuclear basophils, polymorphonuclear eosinophils and polymorphonuclear neutrophils. It is with the latter group that this paper is concerned chiefly.

For many years, differential counts and total counts of the white blood cells have been used as an aid in securing the clinical picture of a disease, the total number of cells and the distribution of types being used mainly as an index of the type of disease present, and the degree of its severity.

In many instances, however, the question in the physician's or surgeon's mind is how to explain certain incompatibilities which arise between the total leukocyte count, the differential smear, and the clinical observations in the case in question.

A distinct advance was made in 1904 and 1905 by Arneth,[1] working at the Leube clinic, when he studied the changes in the nuclear structure of the neutrophils during acute infections. He made a primary division of the polymorphonuclear neutrophils into five classes, each class being recognized by the number of segmentations to the nuclei, the fifth class including those containing five or more distinct segments. He further subdivided these and also the lymphocytes and monocytes until he had in all eighty-one subdivisions.

This was a rather complicated picture, to say the least, as far as being of practical value in making a differential count, but it gave a lead as to the changes occurring in these cells in infections, and a possible explanation of these changes.

In his study Arneth observed that normally the predominating type of polymorphonuclears in the blood stream consisted of those which contain two or more segments, from 90 to 95 per cent being of this class. He showed that the class I polymorphonuclear neutrophil containing an unsegmented nucleus is a young or immature cell

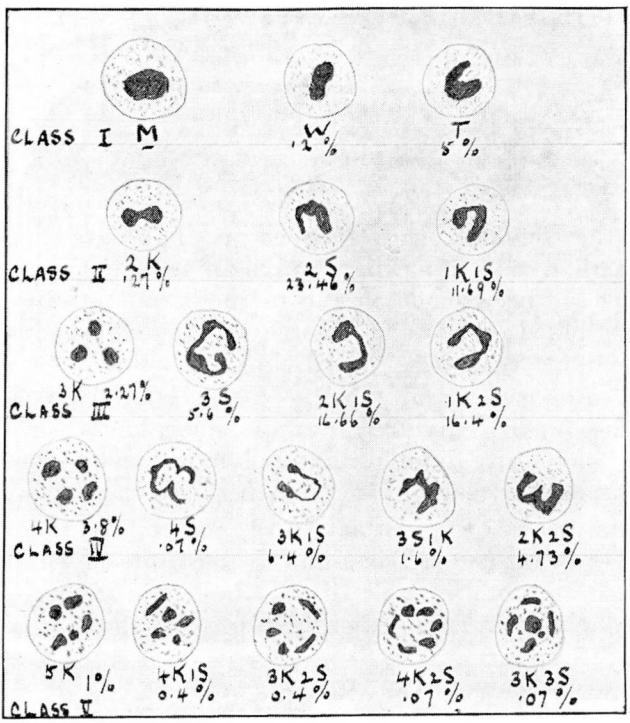

Fig. 1 — Classifications of polymorphonuclear neutrophils by Arneth. From Cooke and Ponder: The Polynuclear Count.

and that the age of the cell is decided by the extent of the segmentation. Arneth pointed out that in acute infection these immature cells increase in number, while the older cells show a corresponding decrease. This change he termed a "shift to the left," and a return from such a change was termed "a shift to the right." These changes are fairly constant, varying with the severity of the infection, the number of immature forms becoming more numerous as the infection grows worse and lessening in number on recovery and convalescence with reversion to the two to five segmented variety.

This appearance of immature forms in the blood stream is explained by a destruction of the normal balance between leukocytic regeneration and degeneration, which is constantly going on in the body. The presence of a leukopenia or a leukocytosis is caused by an inhibition or a stimulation, respectively, of the bone marrow by the bacterial toxin. When increased destruction of white cells occurs in infection, an increasing demand is put on the bone marrow, which is unable to cope with the increasing demand for mature cells and therefore immature cells are poured out.

Although Arneth's observations promoted great interest throughout the scientific world and it was recognized that his procedure was of definite value, it did not come into popular laboratory use because of its complexity and the length of time it took to do one count.

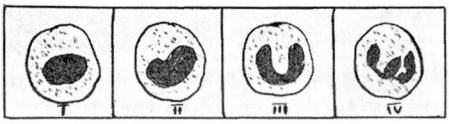

Fig. 2 — Classification of von Schilling, dividing Arneth's class I into three types and placing the remainder of Arneth's classification in class IV; I, myelocyte; II, young form; III, band form; IV, all segmented varieties.

In 1920, von Schilling,[2] of Berlin, after a thorough application of Arneth's methods, published a modification of his classifications. He divided Arneth's class I into three types, the earliest form a

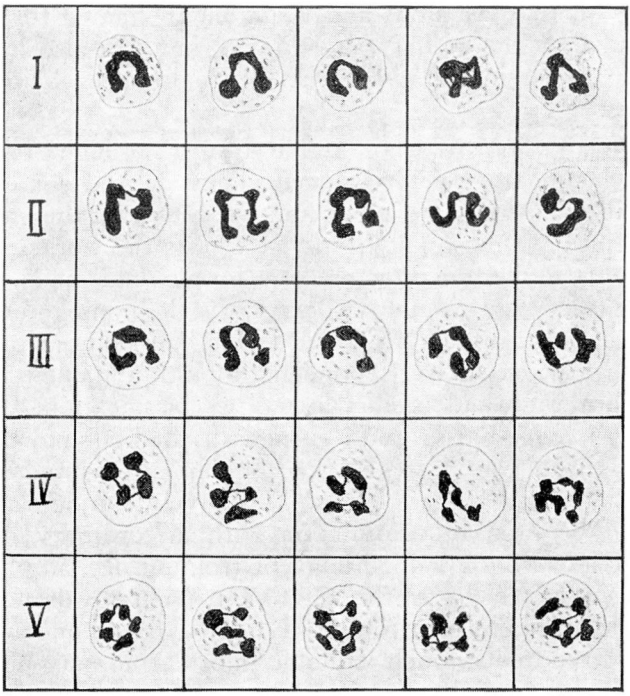

Fig. 3 — Classification of Cooke and Ponder, dividing polymorphonuclear neutrophils into five types, each type being designated by the number of divisions in the nucleus, noting that each nuclear segmentation was connected by a very fine filament of chromatin material. From Cooke and Ponder: The Polynuclear Count.

myelocyte, the second a young form and the third and more advanced a band form. His fourth type included all segmented varieties. A count of this type can be made in five minutes and is of great clinical value. It is surprising that von Schilling's modification has not come into more general use, for wherever it has been instituted its popularity has been immediate and its continued use assured. Von Schilling also noted typical toxic changes occurring both in the nuclear and in the granular elements of the young polymorphonuclears. The granules were larger and more deeply staining, and the nuclei tended to assume more bizarre forms. In addition, the cells were found to be more fragile and occasionally fat droplets and vacuole inclusions were found in the nuclei. These changes he did not consider of as great practical value, however, as the "nuclear shift," since they occurred before the crisis and remained after the crisis and were indicative of degenerative changes in the bone marrow.

Other workers presented various modifications of Arneth's classification. In 1924, Pons and Krumbhaar[3] named three classes; Cooke and Ponder,[4] in 1927, and Piney,[5] in 1928, also made noteworthy advances in the evaluation of qualitative changes in the leukocytes.

In 1930, Farley, St. Clair and Reisinger[6] brought forward the simplest classification yet advanced. They desired a method that could be used as a routine count and yet retain all the value of the more complex systems. They took as a basis the works of Krumbhaar and of Cooke and Ponder. The former had made a division into three classes: (1) metamyelocytes, (2) the nonsegmented types and (3) the segmented forms; the latter had pointed out that all divided nuclear masses were connected by a thin filament of nuclear material but they had used a five type classification. Combining these two systems, Farley and Reisinger divided polymorphonuclear neutrophils into two classes — the nonfilamented immature forms and the filamented mature forms. This gave a simple classification that could be used in conjunction with an ordinary differential count, necessitating no added labor or training. By simply classifying the leukocytes as to the relative percentage of nonfilament neutrophils, filament neutrophils, lymphocytes, monocytes, basophils and eosinophils, much valuable information may be added to the routine differential count.

Farley, St. Clair and Reisinger, in studying the blood of 100 normal adults by the method described, found that an approximate normal upper limit of nonfilament percentage could be set at 16. They also pointed out its value in diagnosing the presence of cryptic

infections and as added presumptive evidence in cases of malingering.

The foregoing classification was used in the cases presented in this paper because of its simplicity of procedure while retaining all the valuable information of the former more complex methods. A slight modification was made in that instead of basing our observations on a count of 100 leukocytes, figures are reported on 100 polymorphonuclear neutrophils counted as well.

TABLE 1

Maximum Nonfilament Percentages

Disease	*Non-filament Percentage*	*Total Leukocyte Count*
Hemolytic streptococcic septicemia	60	4,200*
Hemolytic streptococcic septicemia	72	32,000*
Acute appendicitis	21	15,000
Acute appendicitis	42	23,000
Acute appendicitis	20	11,600
Acute appendicitis	30	16,000
General peritonitis	64	3,000*
Hemolytic streptococcic sore throat	46	9,250
Lobar pneumonia	50	33,200*
Acute pansinusitis	42	9,800
Acute sinusitis (frontal)	22	10,600
Acute sinusitis (maxillary)	15	17,800
Acute sinusitis (frontal and maxillary)	17	9,400
Acute sinusitis (maxillary)	31	12,050
Acute sinusitis (maxillary)	27	11,600
Acute mastoiditis	72	36,200*
Acute mastoiditis	39	20,200
Acute mastoiditis	51	19,800
Acute mastoiditis	36	11,900
Acute mastoiditis	26	16,400
Acute mastoiditis	30	10,800
Acute mastoiditis	62	15,000*
Multiple furuncles	26	16,200
Septic hip	18	14,600
Ruptured gastric ulcer	68	12,200*
Acute cervical adenitis	18	14,300
Acute cervical adenitis	17	14,600
Erysipelas	53	21,000
Acute tonsillitis	35	15,200
Acute labyrinthitis	12	8,800
Acute mediastinitis (following laryngectomy)	54	19,200*
Intestinal obstruction	35	27,800*

*Death occurred.

It will be of interest, perhaps, to outline first the exact method which we use for preparing a satisfactory smear for use in making

this count. Glass cover slips are prepared by thoroughly cleaning them with a rough cleaner such as Dutch Cleanser — this may be done in the palm of the hand, fifty or so slips being cleaned at a time. The cover slips are then rinsed in two washings of distilled water and placed in absolute alcohol for two or three minutes, after which they are dried and polished with a soft cotton cloth. Just before they are used, all dust particles are removed with a fine camel's hair brush. A small drop of blood is obtained in the usual manner and picked up with a cover slip placed in contact with the bleeding point. This cover slip is then dropped on a second cover slip, the drop of blood being allowed to spread out to cover almost

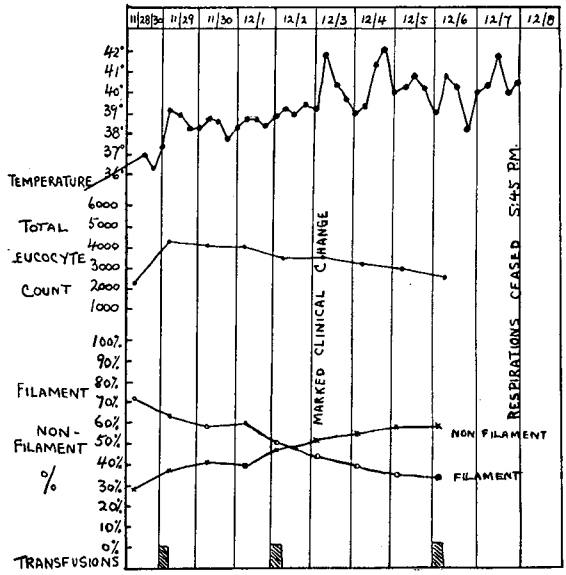

Fig. 4 (case 1) — Hemolytic streptococcic septicemia, generalized hemorrhages, with increasing nonfilament count over 50 per cent, terminating fatally.

the whole area of the slides, when they are gently pulled apart by a sliding motion, one over the other. A thin, even smear will be obtained on the opposing surfaces. Four or six of these smears should be secured on each occasion to be sure of obtaining a good smear. They are then stained by the Wright method, aided by a sodium and potassium phosphate solution with a *p*H of 6.6. The smears are then dried, mounted on a glass slide with gum damar and examined under oil immersion.

We have attempted in the cases here reported to attach a prognostic value to this count and our conclusions are based on the study of some thirty cases of acute infection taken from all

services in the hospital. In all instances in which it was possible to do so, daily counts were made and also total leukocyte counts. It would take too much time to discuss each case in detail; consequently the cases studied, with the maximum nonfilament percentage found in each instance, are given in table 1, and a detailed discussion is given of ten of these cases, the majority of which are from services other than the otolaryngologic service, but chosen because they best illustrate the point in question. On examination of fifteen control smears from healthy adult individuals, a range of nonfilament percentages of from 8 to 16 was found, with an average of 12.1 per cent.

TABLE 2

Blood Examinations in Case 1

Date	Red Blood Cells	Total Leukocyte Count	Differential	Non-Filament Percentage	Filament Percentage
11–28–30	2,740,000	2,600	82% P.; 16% L.; 2% E.	30	70
11–29–30	--------	4,200	72% P.; 23% L.; 4% E.; 1% B.	38	62
11–30–30	--------	4,000	72% P.; 26% L.; 2% E.	42	58
12– 1–30	--------	4,000	74% P.; 14% L.; 3% E.; 9% M.	41	59
12– 2–30	--------	3,800	76% P.; 20% L.; 1% E.; 3% M.	48	52
12– 3–30	--------	3,600	82% P.; 18% L.	53	47
12– 5–30	--------	3,000	79% P.; 17% L.; 1% B.; 3% M.	56	44
12– 6–30	--------	3,200	84% P.; 14% L.; 2% M.	60	40

Case 1.— A man, aged 35, admitted to the clinic, November 28, 1930, complained of shortness of breath, masses on the thighs and groins, hemorrhage from the nose, and severe furunculosis of the face. Physical examination showed the spleen to be markedly enlarged and extensive areas of hemorrhage were present in the

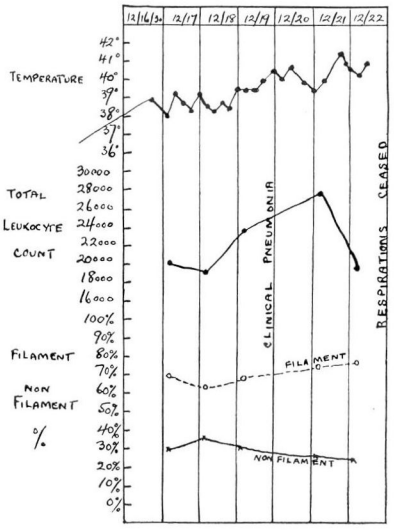

Fig. 5 (case 2) — Acute intestinal obstruction and general peritonitis with constant high nonfilament count.

subcutaneous tissues of the arms, trunk and legs; there were large areas of furunculosis on the face and marked hemorrhage from the mucous membrane of the nose and throat.

The patient was vomiting blood, but no blood was found in the stools or urine. The patient died, December 7th.

Here is pictured plainly a steadily increasing nonfilament count terminating in death, the nonfilament change preceding the changes in clinical symptoms, as seen in figure 4.

Pneumonia was noted clinically, December 3, with no change in the differential or white blood count, but a rise of 7 per cent in the nonfilament count preceded this condition by twenty-four hours.

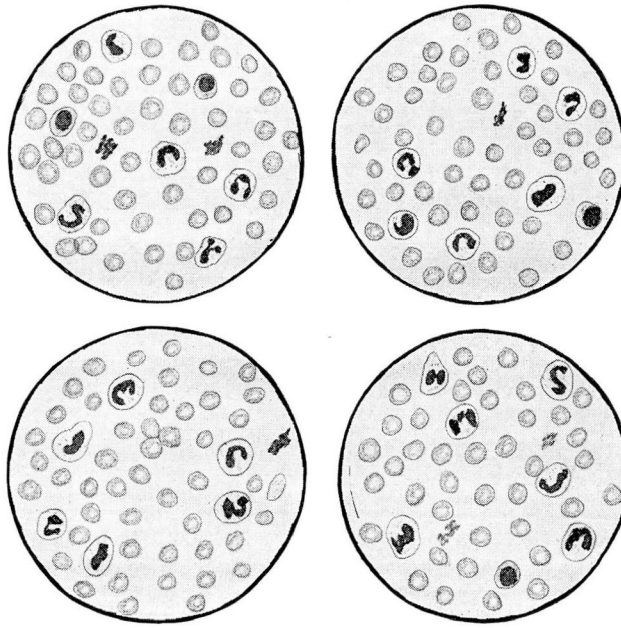

Fig. 6 (case 2) — Toxic changes in the nuclear structure of the polymorphonuclear neutrophils in a case of ruptured gastric ulcer and general peritonitis on the first, third, fourth and sixth days.

This case is a good example of the additional information that may be obtained from a count of this type. Postmortem examination revealed hemolytic streptococci from the heart's blood, although blood cultures during the course of the illness were repeatedly negative, terminal pneumonia and hemorrhages from all the mucous surfaces being the final cause of death.

Case 2.— A woman, aged 60, was admitted to the Cleveland Clinic Hospital with a history of severe pain in the right upper

quadrant, associated with nausea and vomiting, persisting for five days previous to admission. The vomitus had a fecal odor and no gas or feces had been passed by the rectum. An enema given two days previous to her admission had returned blood-stained but clear. For two days previous to the patient's admission there had been no vomiting. Marked distention was present. The patient was never in a condition for operation during her stay in the hospital.

In this case is found rather than a steady increase, a constant high nonfilament percentage, beginning at over 30 with a gradual terminal fall. This is not a typical example of the increasing nonfilament percentage, but an interesting point in this case was the presence of marked toxic changes in the nuclei as illustrated in figure 6.

TABLE 3

Blood Examinations in Case 2

Date	*White Blood Cells*	*Differential*	*Non-Filament Per-centage*	*Fila-ment Per-centage*
12–17–30	20,000	84% P.; 13% L.; 3% M.	30	70
12–18–30	19,800	87% P.; 10% L.; 3% E.	35	65
12–19–30	24,000	86% P.; 8% L.; 4% E.; 2% M.	30	70
12–21–30	27,800	89% P.; 7% L.; 2% E.	28	72
12–22–30	20,200	94% P.; 4% L.; 2% M.	25	75

The patient showed steadily increasing weakness and toxicity, but, as has been pointed out, she was in no condition for operative intervention. Although a high white blood count was present throughout the disease, the marked change in the nonfilament percentage is not seen, perhaps because of the decrease in bone marrow activity. The patient died on the sixth hospital day.

Case 3.— A man, aged 62, was admitted to the clinic, November 7, 1930, with a history of having had glands removed from his neck eleven months previously, the condition having been diagnosed at that time as carcinoma. The immediate history included hoarseness for two months and marked difficulty in breathing for one week. Tracheotomy was performed on the day the patient was admitted and laryngectomy five days later. Infection occurred from the mouth through a pharyngeal fistula, and mediastinitis followed in spite of all treatment.

The patient was not seen until infection was well advanced, but the rapid rise seen on the second count was of grave prognostic significance even before the clinical picture was indicative of a possible fatal issue.

November 28, clinical bronchopneumonia was present late in the day, whereas a marked rise had already been noted in the nonfilament percentage that morning. The persistent high level of non-

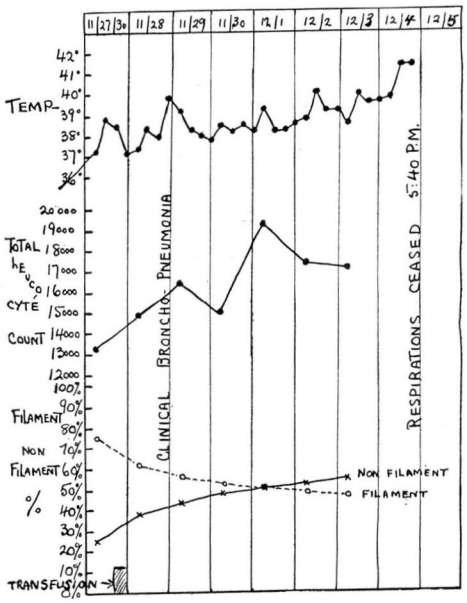

Fig 7 (case 3) — Acute mediastinitis and bronchopneumonia following laryngectomy, showing increasing nonfilament count, terminating fatally.

TABLE 4

Blood Examinations in Case 3

Date	*White Blood Cells*	*Differential*	*Non-Filament Percentage*	*Filament Percentage*
11–27–30	13,200	84% P.; 13% L.; 2% E.; 1% B.	25	75
11–28–30	14,800	86% P.; 12% L.; 2% M.	38	62
11–29–30	16,400	85% P.; 21% L.; 1% B.; 2% E.	44	56
11–30–30	15,000	88% P; 10% L.; 1% E.; 1% M.	48	52
12– 1–30	19,200	95% P.; 5% L.	50	50
12– 2–30	17,450	85% P.; 13% L.; 2% M.	52	48
12– 3–30	17,200	84% P.; 13% L.; 3% M.	54	46

filament cells slowly increasing to 50 per cent is well illustrated here in a case which terminated fatally.

Case 4.— A man, aged 32, entered the clinic suffering from a typical attack of appendicitis of sixteen hours' duration. The course of examinations of the blood during his hospitalization is shown in table 5.

Here is seen the gradual steady return to normal percentage of the nonfilament cells in an uncomplicated case of acute appendicitis. As seen in figure 8, the white blood count showed a very rapid drop in twenty-four hours, January 5, 1931. Although clinical signs of bronchopneumonia were recorded on this date, the lungs were perfectly clear the following day and the temperature returned to

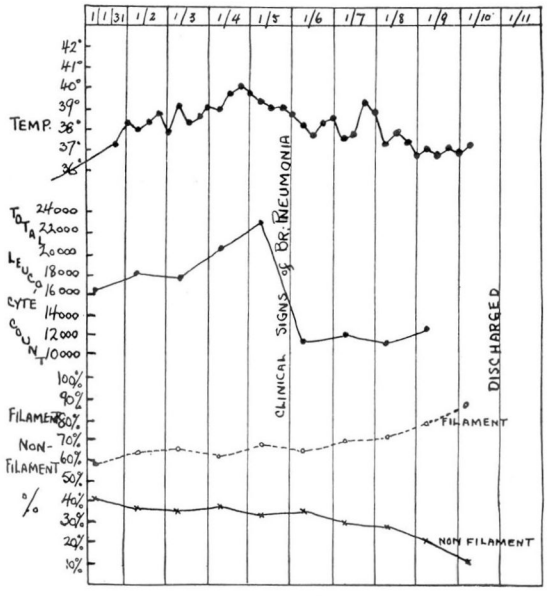

Fig. 8 (case 4) — Acute appendicitis, showing steady decrease of nonfilament count to normal in uncomplicated convalescence.

TABLE 5

Blood Examinations in Case 4

Date	*White Blood Cells*	*Differential*	*Non-Filament Percentage*	*Filament Percentage*
1– 1–31	16,800	----------	42	58
1– 2–31	18,000	----------	36	64
1– 3–31	17,800	----------	35	65
1– 4–31	20,600	----------	37	63
1– 5–31	23,000	93% P.; 6% L.; 1% M.	33	67
1– 6–31	10,800	82% P.; 15% L.; 1% E.; 2% M.	35	65
1– 7–31	11,000	80% P.; 18% L.; 2% M.	22	78
1– 8–31	11,200	----------	28	72
1– 9–31	12,400	76% P.; 18% L.; 2% E.; 4% M.	21	79
1–10–31	10,200	78% P.; 18% L.; 4% M.	12	88

normal. The nonfilament count showed no change for the worse at this time, and it is hardly likely that any degree of infection was present in the lungs. The patient made satisfactory postoperative progress.

Case 5.— A man when first seen was complaining of severe cold in the head, of ten days' duration; headache was a marked symptom, accompanied by a profuse nasal discharge. Treatment was instituted and a large amount of pus was obtained by suction from both nostrils.

On the fourth day of observation the left maxillary antrum was irrigated without difficulty through the natural opening. The

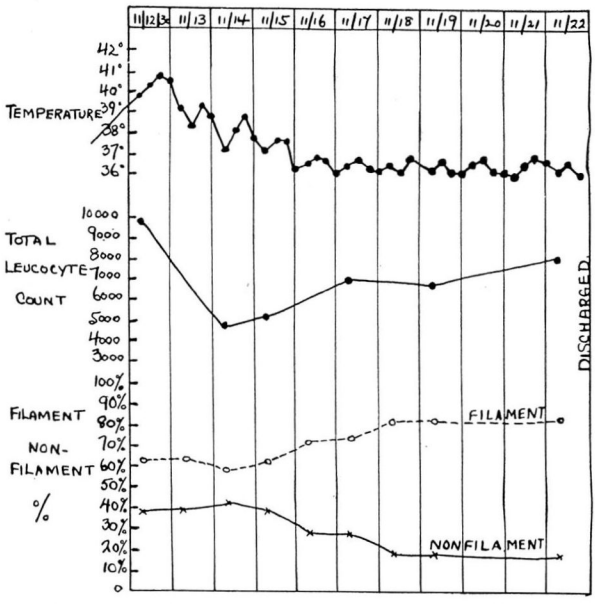

Fig. 9 (case 5) — Acute bilateral maxillary sinusitis, showing steady return of nonfilament count to normal during convalescence.

TABLE 6

Blood Examinations in Case 5

Date	*White Blood Cells*	*Differential*	*Non-Filament Per-centage*	*Fila-ment Per-centage*
11–12–30	9,800	91% P.; 9% L.	38	62
11–13–30	------	------	38	62
11–14–30	4,805	72% P.; 28% L.; 1% B.	42	58
11–15–30	5,200	65% P.; 34% L.; 1% E.	38	62
11–16–30	------	70% P.; 24% L.; 4% E.; 2% B.	28	72
11–17–30	7,000	70% P.; 28% L.; 2% E.	27	73
11–18–30	------	------	18	82
11–19–30	6,800	82% P.; 15% L.; 3% E.	17	83
11–22–30	8,000	66% P.; 28% L.; 2% M.; 2% E.	16	84

return was clear. Reaction occurred the following day, the temperature rising to 102 F.; chills occurred.

Conservative treatment was followed and after a week, when marked evidence of sinus involvement was present, the left antrum was again irrigated and a large amount of pus obtained. The following day the patient again suffered a severe reaction and was admitted to the hospital.

The patient showed steady improvement after the third day, as evidenced by the temperature curve and the nonfilament percentage. This improvement, however, is not reflected in the total leukocyte count. This case is also an interesting example of the reactions that may follow the simple washing of an acutely infected sinus.

Case 6.— A man was admitted to the hospital in a critical condition, suffering from severe abdominal pain and general collapse of three days' duration. Immediate operation was performed and a ruptured gastric ulcer with localized peritonitis was found. Repair and drainage were instituted and the patient made satisfactory progress until the third postoperative day.

TABLE 7
Blood Examinations in Case 6

Date	White Blood Cells	Differential	Non-Filament Percentage	Filament Percentage
12– 9–30	12,000	88% P.; 11% L.; 1% M.	68	32
12–10–30	11,000	85% P.; 14% L.; 1% B.	64	36
12–11–30	12,200	88% P.; 10% L.; 1% E.; 1% M.	30	70
12–12–30	7,800	83% P.; 14% L.; 3% M.	43	57
12–13–30	6,400	85% P.; 12% L.; 3% M.	48	52
12–14–30	8,700	87% P.; 7% L.; 2% E.; 4% M.	39	61
12–15–30	8,600	78% P.; 21% L.; 1% M.	42	58

Here is seen an acute abdominal condition with a very high nonfilament percentage before operation. Following operation and drainage, the nonfilament percentage gradually fell until the third postoperative day, when a marked rise was noted. Later on this day the patient's general clinical condition was markedly worse. Complications were suspected and on examination of the wound and abdomen a breaking down of the operative area was found and a diagnosis of general peritonitis was made. In spite of all treatment, the patient became steadily worse, the nonfilament count rising again with a fatal termination.

The total leukocyte count here again was never as high as one would suspect from the clinical picture, ranging, as seen in figure 10, from 6,000 to 12,000 and not following the clinical course as did the filament-nonfilament count.

Case 7.— A man, giving a typical history of acute appendicitis, was operated on immediately after his admission to the hospital.

Table 8 shows the white blood count fluctuating quite markedly throughout the convalescence, but the patient showed very satisfactory postoperative progress, with the rapid return of the nonfilament relation to normal.

TABLE 8
Blood Examinations in Case 7

Date	White Blood Cells	Differential	Non-Filament Percentage	Filament Percentage
12– 8–30	15,000	86% P.; 12% L.; 2% M.	31	69
12– 9–30	11,000	85% P.; 15% L.	19	81
12–10–30	12,400		15	85
12–11–30	8,200		18	82
12–12–30	12,600		14	86
12–13–30	11,000		12	88
12–14–30	10,200			
12–16–30	9,500		12	88

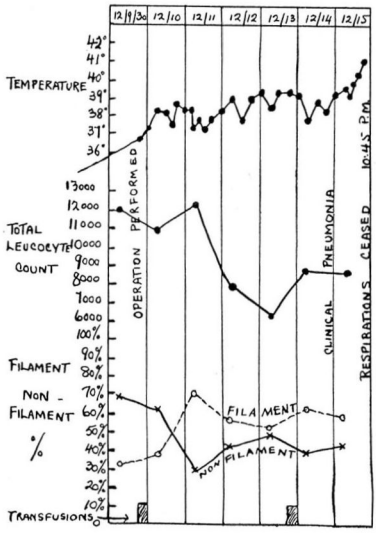

Fig. 10 (case 6) — Ruptured gastric ulcer and general peritonitis illustrating fatal termination with high nonfilament count and secondary rise of nonfilament count indicating complications.

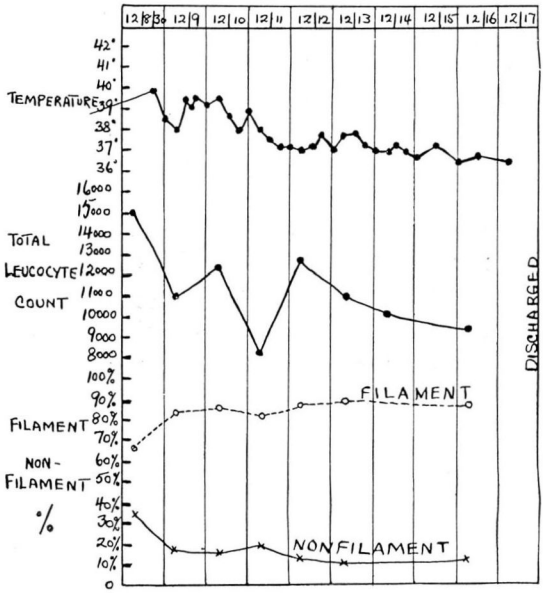

Fig. 11 (case 7) — Acute appendicitis, showing return of nonfilament count to normal in uncomplicated convalescence.

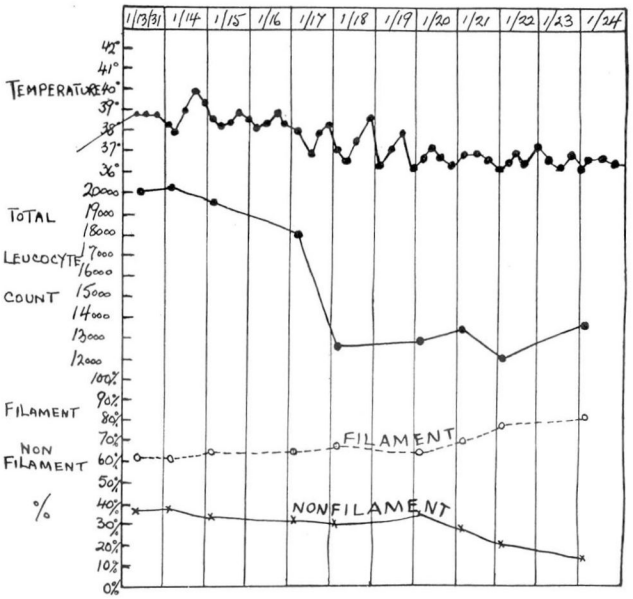

Fig. 12 (case 8) — Acute mastoiditis, showing steady return of nonfilament count to normal in uncomplicated convalescence. The patient was discharged, January 25, 1931.

TABLE 9
Blood Examinations in Case 8

Date	*White Blood Cells*	*Differential*	*Non-Filament Per-centage*	*Fila-ment Per-centage*
1–31–31	20,000	80% P.; 18% L.; 2% M.	38	62
1–14–31	20,200		39	61
1–15–31	19,500		35	65
1–17–31	18,000	88% P.; 12% L.	32	68
1–18–31	12,400	77% P.; 16% L.; 3% E.; 4% M.	31	69
1–20–31	13,000	79% P.; 16% L.; 1% E.; 4% M.	33	67
1–21–31	13,800		30	70
1–22–31	12,200		24	76
1–24–31	14,000		16	84

Case 8.— A boy, aged 12 years, was admitted to the clinic with a typical history of acute mastoiditis. Operation was performed and the patient's convalescence was very satisfactory.

This case is an example of satisfactory convalescence following operation in acute mastoiditis. Here again the nonfilament count follows closely the clinical improvement.

Case 9.— A woman, aged 35, was admitted to the clinic with an acute abdominal condition. The history was generally unsatisfactory. A diagnosis of general peritonitis was made, but the clinical picture was not critical, although the patient's temperature on admission was 104 F. The blood examinations in case 9 is shown in table 10.

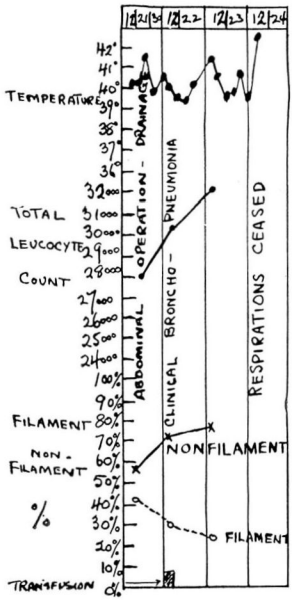

Fig. 13 (case 9) — General peritonitis, illustrating high nonfilament count in fatal case.

TABLE 10

Blood Examinations in Case 9

Date	*White Blood Cells*	*Differential*	*Non-Filament Per-centage*	*Fila-ment Per-centage*
12–21–30	28,000	99% P.; 1% L.	58	42
12–22–30	30,200	93% P.; 5% L.; 2% M.	70	30
12–23–30	32,000		72	28
12–24–30	Death			

Table 10 shows a very high nonfilament percentage on admission but a clinical picture that is not critical. The patient seemed to be in good condition generally, was not extremely toxic, and the heart and lungs were normal. On the second day, the patient's clinical condition was much worse, with early signs of bronchopneumonia and general collapse. She became rapidly worse and died on the fourth hospital day. This case illustrates the high nonfilament count giving a poor prognosis twenty-four hours before the clinical conditions became alarming.

Case 10.— A boy, aged 6 years, gave a history of acute pain in the right ear six weeks previous to admission. The right ear had been discharging during this period and periodic attacks of chills and high temperature occurred. The diagnosis was acute mastoiditis with probable sinus thrombosis and blood stream infection, although the patient's condition appeared to be good.

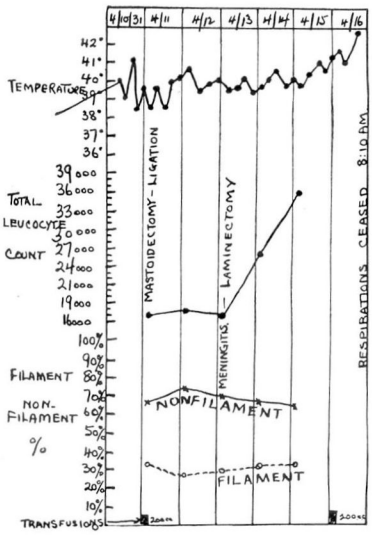

Fig. 14 (case 10) — Acute mastoiditis with jugular thrombosis and meningitis, showing constant high nonfilament count with a fatal termination.

TABLE 11
Blood Examinations in Case 10

Date	*White Blood Cells*	*Differential*	*Non-Filament Per-centage*	*Fila-ment Per-centage*
4–11–31	17,000	78% P.; 22% L.	66	34
4–12–31	17,200	81% P.; 15% L.; 4% M.	72	28
4–13–31	17,000	82% P.; 14% L.; 4% M.	70	30
4–14–31	26,600	92% P.; 6% L.; 2% M.	68	32
4–15–31	36,200	88% P.; 6% L.; 6% M.	66	34

TABLE 12
Nonfilament Counts in Infectious and Noninfectious Types of Arthritis

Case	*Noninfectious, Per Cent*	*Infectious, Per Cent*
1	----	14
2	----	15
3	8	----
4	----	13
5	9	----
6	----	22
7	----	29
	17	93
Average	8.5	18.6

TABLE 13
Eosinophilic Percentage in Allergic Phenomena

Case	*Protein Sensitization, Per Cent*	*Infectious, Per Cent*	*Eosinophils Per Cent*
1	----	16	3
2	----	25	12
3	7	----	6
4	15	----	4
5	----	18	7
	22	59	
Average	11	19.6	

On operation, the patient was found to have a very acute mastoid condition, with thrombosis of the lateral sinus extending down the jugular vein almost to the level of the clavicle. A mastoid operation was performed, the lateral sinus exposed and the jugular vein tied off. Postoperatively, an abscess developed about the jugular vein with meningitis, and the child died on the sixth postoperative day.

This is another example of an extremely high nonfilament count with a total leukocyte count lower than would be expected. Here, again, is found a very high nonfilament count at the beginning of the period of observation, which, following operation, dropped in only a slight degree; although the nonfilament percentage showed a slow decrease, it was so high at the onset that a favorable prognosis could not be expected.

Seven cases of arthritis were studied to see whether any change could be noted in those cases in which the condition could be definitely attributed to an infectious origin. The results were rather promising in that those cases of the infectious type showed an average nonfilament count of 18.6 per cent, whereas the cases of noninfectious origin showed an average count of only 8.5 per cent. The individual counts are shown in table 12.

Table 12 brings out the possibility of an aid to differentiation in this type of case in which any added information is of definite value.

A limited number of cases of allergic phenomena were also studied, and it was found as a general rule in cases in which the asthma could be attributed to foci of infection that the nonfilament count was higher than in those cases in which the condition could be traced to definite protein sensitization.

In these cases, also, the eosinophilic percentage was interesting in that practically all showed eosinophils of over 4 per cent.

We were greatly interested in the observations of Dr. G. A. Winfield,[7] of the Cleveland Clinic, in his work on malarial treatment of syphilis. In these cases, nonfilament counts were observed following inoculation with the malarial parasite and very high percentages were noted, ranging as high as from 70 to 80 per cent of nonfilament forms with a marked leukopenia. This was extremely interesting in that none of these cases terminated fatally. It was interesting to note the rapidity with which the changes occurred and also the constancy with which the nonfilament percentage followed the course of the reactions. Dr. Winfield notes the nonfilament percentage to be the most constant blood picture in this treatment.

Conclusions

1. The filament-nonfilament count as outlined is a valuable aid in securing the clinical picture of disease, following more closely the course of the infection than the total leukocyte count and foretelling complications in convalescence.

2. In nonfilament counts of 50 per cent and over, a very guarded prognosis must be given. The majority of such cases reach a fatal termination.

3. Filament-nonfilament counts may prove valuable aids in the differential diagnosis of infections from non-infectious allergies and arthritides.

4. Filament-nonfilament counts may prove a valuable basis by which to gage the dosage of malarial injection in the treatment of syphilis.

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