Staff Meeting Bulletin
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University of Minnesota

Electrical Techniques In Neurological Diagnosis

Volume XVIII | Friday, June 6, 1947 | Number 29

STAFF MEETING BULLETIN
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INDEX

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William A. O'Brien, M.D.

I.

UNIVERSITY OF MINNESOTA MEDICAL SCHOOL
CALENDAR OF EVENTS

June 9 - June 14, 1947

No. 161

Monday, June 9

9:00 - 9:50 Roentgenology-Medicine Conference; L. G. Rigler, C. J. Watson and Staff; Todd Amphitheater, U. H.

9:00 - 10:50 Obstetrics and Gynecology Conference; J. L. McKelvey and Staff; Interns' Quarters, U. H.

10:00 - 12:00 Neurology Ward Rounds; A. B. Baker and Staff; Station 50, U. H.

11:00 - 11:50 Roentgenology-Medicine Conference; Staff; Veterans' Hospital.

11:00 - 11:50 Physical Medicine Conference; Progressive relaxation; G. Keith Stillwell; E-101, U. H.

12:15 - 1:20 Obstetrics and Gynecology Journal Club; M-435, U. H.

12:30 - 1:20 Pathology Seminar; Chronic interstitial pneumonia; Kano Akeda; 104 I. A.

12:15 - 1:20 Pediatrics Seminar; Report on program of national meetings; 6th Floor Seminar Room; U. H.

12:30 - 1:50 Surgery Grand Rounds; A. A. Zierold, Clarence Dennis and Staff; Minneapolis General Hospital.

Tuesday, June 10

9:00 - 9:50 Roentgenology-Pediatrics Conference; L. G. Rigler, I. McQuarrie and Staff; Eustis Amphitheater, U. H.

8:30 - 10:20 Surgery Seminar; John R. Paine; Small Conference Room, Bldg. I, Veterans' Hospital.

10:30 - 11:50 Surgical-Pathological Conference; John R. Paine and Nathanial Lufkin; Veterans' Hospital.

12:30 - 1:20 Pathology Conference; Autopsies; Pathology Staff; 102 I. A.

2:00 - 2:50 Dermatology and Syphilology Conference; H. E. Michelson and Staff; Bldg. III, Veterans' Hospital.

3:15 - 4:20 Gynecology Chart Conference; J. L. McKelvey and Staff; Station 54, U. H.

3:30 - 4:20 Clinical Pathological Conference; Staff; Veterans' Hospital.

3:45 - 4:50 Pediatrics Staff Rounds; I. McQuarrie and Staff; W-205, U. H.

Wednesday, June 11

8:00 - 8:50 Surgery Journal Club; O. H. Wangensteen and Staff; M-515, U. H.

8:30 - 9:50 Psychiatry and Neurology Seminar; Staff; Veterans' Hospital.

11:00 - 11:50 Pathology-Medicine-Surgery Conference; Carcinoma head of pancreas; E. T. Bell, C. J. Watson, O. H. Wangensteen and Staff; Todd Amphitheater.

12:00 - 12:50 Physiological Chemistry Journal Club; Staff; 113 MeS.

7:30 - 8:50 Histopathology of the Skin; Dermatology Staff; Todd Amphitheater, U. H.

Thursday, June 12

8:30 - 9:20 Surgery Grand Rounds; John R. Paine and Staff; Veterans' Hospital.

9:00 - 9:50 Medicine Case Presentation; C. J. Watson and Staff; Todd Amphitheater, U. H.

10:00 - 11:50 Medicine Ward Rounds; C. J. Watson and Staff; E-221, U. H.

10:30 - 11:50 Surgery-Radiology Conference; Daniel Fink and John R. Paine, Veterans' Hospital.

12:00 - 12:50 Physiological Chemistry Seminar; Lipid Metabolism; Walter O. Lundberg; 214 M. H.

1:00 - 1:50 Fracture Conference; A. A. Zierold and Staff; Minneapolis General Hospital.

4:30 - 5:20 Ophthalmology Ward Rounds; Erling W. Hansen and Staff; E-534, U. H.

7:30 - 8:50 Physical Medicine Seminar; William G. Kubicek; 111 MeS.

Friday, June 13

9:00 - 9:50 Medicine Grand Rounds; C. J. Watson and Staff; Todd Amphitheater, U.H.

9:00 - 9:50 Pediatric Grand Rounds; I. McQuarrie and Staff; Eustis Amphitheater, U. H.

10:00 - 11:50 Medicine Ward Rounds; C. J. Watson and Staff; E-221, U. H.

10:30 - 11:20 Medicine Grand Rounds; Staff; Veterans' Hospital.

10:30 - 11:50 Otolaryngology Case Studies; L. R. Boies and Staff; Out-Patient Department; U. H.

1:00 - 1:50 Dermatology and Syphilology; Presentation of Selected Cases of the Week; H. E. Michelson and Staff; W-312, U. H.

1:00 - 2:50 Neurosurgery-Roentgenology Conference; W. T. Peyton, Harold O. Peterson, and Staff; Todd Amphitheater, U. H.

5:30 - 6:20 Surgery Literature Conference; Clarence Dennis and Staff; Minneapolis General Hospital.

Saturday, June 14

7:45 - 8:50 Orthopedics Conference; Wallace H. Cole and Staff; Station 21, U. H.

9:00 - 9:50 Neurology Grand Rounds; A. B. Baker and Staff; Station 50, U. H.

9:00 - 9:50 Surgery-Roentgenology Conference; O. H. Wangensteen, L. G. Rigler, and Staff; Todd Amphitheater, U. H.

9:00 - 9:50 Medicine Case Presentation; C. J. Watson and Staff; M-515, U. H.

10:00 - 11:50 Medicine Ward Rounds; C. J. Watson and Staff; M-515, U. H.

10:00 - 12:50 Obstetrics and Gynecology Grand Rounds; J. L. McKelvey and Staff; Station 44, U. H.

II. ELECTRICAL TECHNIQUES IN NEUROLOGICAL DIAGNOSIS

R. A. Anthony

Historical

In 1745[1] Kratzenstein published the first report describing muscle contraction after stimulation with static electricity. Many years later, Galvani[2], 1786, after noting that frogs' legs developed contractions when they were suspended by copper hooks from an iron ballustrade, concluded that animals produce electricity. He was wrong in his reasoning as we know, but his conclusions were correct. His publications resulted in much interest and many investigations into what he termed "animal electricity". Actual measurements of :animal electricity" were not made until 1824 when Nobili[3] made use of the galvanometer which had been developed some six years before.

Since that time continued attempts have been made to study nerves and muscles either by sending currents into these tissues or measuring the currents which they produce when in action. As progress was made in measuring and recording potential changes and in controlling the production of currents, techniques have become more refined in the use of the electrical phenomenon in the study of nerves and muscles. By using the electron vacuum tube it is possible to record the small voltage changes of short duration that accompany neuro-muscular action. This tube has resulted in the development of greatly improved means of stimulating nervous tissue with currents whose characteristics are completely controlled.

It is the purpose of this talk to describe briefly some of the electrical techniques used in the study of neurological disorders, both the recording of electrical changes present in neuro-muscular tissues and the results noted when these tissues are stimulated by well controlled currents.

Chronaxie

This measurement of the excitation time of muscle has been the subject of many controversial statements, particularly in respect to its theoretical interpretation. Adrian[4] has shown that changes occur in the chronaxie of muscles whose nerve supply has been interrupted.

If a constant technique and an accurate instrument is used it is possible to use the changes in chronaxie as a means of following the degenerative and regenerative changes that occur in muscles whose nerves have been cut. At the U. S. Naval Hospital, St. Albans, N. Y., chronaxie studies were made of the muscles of naval and marine personnel who had received nerve injuries.

The apparatus used was one devised by Golseth and Fizzell[5] and constructed at the Mercy Jones General Hospital, Battle Creek, Michigan. This instrument produces a square wave (unidirectional) whose duration can be varied between 0.001 and 1.5 seconds in seventeen steps. The interval between these stimuli can be changed from 0.001 to 4.0 seconds in five steps. It is so constructed that variations in the resistance of the patient do not alter the value of the current flow. The indifferent electrode measured four cm. and the active electrode measured one-half to one cm. When the test was repeated the same point was used by referring to notations made at the first examination. In this manner the same area was tested each time measurements of the chronaxie were made.

The following cases illustrate the changes that take place in uncomplicated nerve injuries in healthy young men before and after suture of the injured nerve.

Case 1.

Table No. 1 shows the chronaxie of the opponens pollicis and abductor pollicis brevis muscles of a 23-year old marine whose median nerve had been injured 91 days before. Examination of the involved hand showed atrophy and paralysis of the muscles about the thumb, as well as increased skin resistance and inability to feel pin prick (28 grams pressure) over the skin area supplied by the median nerve. At operation five days later a I cm. gap was

found and the nerve was sutured by the plasma glue method of Tarlov[6]. Over a hundred days after suture the chronaxie had fallen, the muscles reacted to stimulation of the median nerve and sensory as well as skin resistance studies showed regeneration.

Case 2.

Table No. 2 is the record of the chronaxie readings of two muscles supplied by the ulnar nerve. Two days before examination the patient had pushed his arm through a glass window, severing his ulnar nerve as well as several tendons. Six days later the wound was explored and the severed ulnar nerve sutured by the plasma glue method. Table Jo. 2 shows that the chronaxie continued to go up after suture and did not fall until fifty days after suture. This is in keeping with the speed of the growth of the proximal segment and the time required for regeneration to take place in the muscles.

Case 3.

Table No. 3 is the record of the chronaxie readings on a 19 year old sailor whose ulnar nerve had been injured by a knife. Inability to feel pin prick, increased skin resistance over the area supplied by the ulnar nerve and atrophy and paralysis of the muscles supplied by the ulnar nerve were noted. At operation the ulnar nerve was found to be severed and it was sutured. Table No. 3 shows the gradual drop in the chronaxie following suture.

Strength Duration Curve

An attempt was made to study the strength duration curves of muscles in nerve injuries. However, considerable difficulty was encountered and the results obtained generally were not considered reliable. Table No. 4 illustrates strength duration curves obtained in one normal and two abnormal abductor digiti V muscles.

Galvanic Tetanus Ratio

The galvanic tetanus ratio of Pollock et al[5] is the ratio between the current required to produce a liminal response (expressed in milliamperes) and the current required to produce a sustained response, when the duration of the current is two seconds. These investigators showed that the tetanus ratio of normal muscles was between three and six. This ratio fell during degeneration to unity and greatly increased during and after regeneration. In cases which are uncomplicated by severe vascular injuries, destruction of muscular tissue and long periods of immobilization in healthy young men the galvanic tetanus ratio falls in degeneration and increases during regeneration. If there is partial interruption of the nerve or the other factors mentioned above this ratio may remain quite high. The following are illustrative cases in uncomplicated nerve injuries. Usually in such patients the galvanic tetanus ratio was found to be between 2 and 1.1 Rarely was the tetanus ratio unity.

The instrument and technique as described above for the study of chronaxie was used in determining the galvanic tetanus ratio.

Case 4.

Table No. 5 shows the galvanic tetanus ratio of the tibialis anticus and extensor hallucis longus muscles 42 days after injury of the common peroneal nerve by a bullet. On surgical exploration a large neuroma was found at the site of injury. The neuroma was removed and the nerve sutured. Galvanic tetanus ratio readings taken sixty-eight days after this showed a greatly increased tetanus ratio. Movement returned to the involved muscles thirty-nine days after this.

Case 5.

Table No. 6 demonstrates the tetanus ratios of two muscles supplied by an ulnar nerve which had been injured 11 days before examination. At that time the ratio was normal. However, when it had dropped to 1.1 thirty-two days after injury, it was concluded that the nerve was interrupted and the injury was explored forty-five days after the injury. The nerve was found to be severed and was sutured. The ratio continued to remain near unity until the 45th day after the nerve was sutured at which time an increase in the tetanus ratio was noted.

Movement on stimulation of the ulnar nerve and an increase in the tetanus ratio was noted on the 59th day after suture. Sensory and skin resistance changes indicated recovery to some extent at this time.

Case 6.

Table No. 7 shows the findings on a 20 year old sailor who injured his ulnar nerve 4 days before examination. The tetanus ratio was normal since degenerative changes had not occurred. However, the history of the injury indicated that he probably had interruption of the ulnar nerve. At operation the ulnar nerve was found to be interrupted and was sutured by the plasma glue method. As Table No. 7 shows at the 79th day after suture the galvanic tetanus ratio was near unity. Other examinations, skin resistance changes, response to pin prick and chronaxie showed no evidence of regeneration. Unfortunately, I was not able to further study the case and do not know what course followed.

Electrical Skin Resistance

Richter and Katz[7] showed that there was a correlation between the electrical skin resistance and sensory changes in peripheral nerve injuries. Skin resistance changes can be measured by a simple dermometer[8]. Essentially, this instrument is an ohmmeter and consists of a microammeter, a 4½ volt battery, a 1000 ohm potential divider, connecting wires and two electrodes. One electrode is clipped on the ear after the skin is pierced and Cambridge electrode jelly is applied. The other electrode is a small bronze disc. This second electrode is moved over the areas one wishes to study. When there is a high resistance the microammeter needle does not move and when low skin resistance is encountered the needle swings markedly. This instrument can be so adjusted, using the potential divider, so that the needle will move sharply when the second electrode is placed over normal skin, but will not move when in contact with denervated skin. It is usually necessary to produce sweating in the patient by placing him under a heat cradle for a few minutes. Windows and doors should be kept closed during these examinations.

At the U. S. Naval Hospital, St. Albans, N. Y., this technique was used in conjunction with careful sensory examinations in injuries of the peripheral nerves. The sensory nodality used was that of response to pin prick. An algesiometer similar to that described by Head[9] was used to test pain response. By using this instrument it was possible to apply the same amount of pressure of the pin point at each examination. Most of the studies were made with the instrument so adjusted that the pin was under a pressure of 28 grams. Careful instructions were given to the patient each time the examination was made and every effort was made to have quiet and pleasant surroundings. Head[9] has shown that visual and auditory stimuli may vary sensory studies considerably.

Thirty-seven cases of injury of the ulnar nerve were examined. These cases had showed varying degrees of degeneration and regeneration by other tests. When the response to pin prick and skin resistance was compared in these various cases a high degree of correlation was found between them.

Combined ulnar and median nerve injuries showed a still higher degree of correlation. Twenty-three cases were studied, some cases were observed from two to five times at intervals of two to thirty-two weeks.

Examination of skin resistance changes and response to pin prick in radial nerve injuries revealed little correlation. Many of the cases of radial nerve injury which showed definite degenerative changes when studied by electrical testing of the muscles showed no sensory changes. Many of the cases which showed sensory changes had no skin resistance changes. A poor correlation between sensory changes and skin resistance changes appears to exist in radial nerve injuries.

Of 33 patients with median nerve injuries of various degrees of regeneration a good degree of correlation was noted between pin prick response and

skin resistance.

Twenty-eight cases of injury of the sciatic nerve showed a rather constant relationship between skin resistance and loss of pain sense as measured by pin prick. The area involved in sciatic nerve injuries, when the level of injury was kept in mind, did not show the variations that are frequently encountered in the peripheral nerves of the upper extremity. Both peroneal and tibial nerve injuries showed the same high degree of correlation, that was noted in the sciatic nerve.

Electromyography

The electrical activity of muscles may be recorded by the use of electronic amplifiers and the cathode ray oscilloscope[10,11], using concentric needle electrodes. Weddell, Feinstein and Pattle have shown that changes in the electrical activity occur when the peripheral nerve supply of muscles is interrupted. Normal relaxed muscles show no electrical activity. During contraction the motor unit action potentials very in amplitude from 100 microvolts to 1 mi,livolt and have a duration of 5 to 10 milliseconds, usually being monophasic or diphasic. These changes in potential appear at a rate of 5 to 10 per second in slightly contracted muscles. In strongly contracted muscles they have a frequency of as high as fifty per second.

Studies of denervated muscles show fibrillation action potentials of the rhythmic monophasic or diphasic type whose duration is about 1 to 2 milliseconds, frequency 2 to 10 per second and amplitude about 100 microvolts. These potentials may appear spontaneously, following mechanical stimulation or after the injection of prostigmine. During and after reinnervation these spontaneous action potentials decrease in frequency or disappear and another type of potential appears when an attempt is made to move the involved muscles. These potentials are polyphasic, usually of a higher voltage and greater duration than the potentials seen in normal muscles. The appearance of these potentials is said to be an excellent prognostic sign.[10] Three cases studied by this method at the U. S. Naval Hospital, St. Albans, N. Y. confirmed this.

Electro-encephalography[12,13,14]

By means of electronic amplifiers and ink writers it is possible to record the changes in electrical potential that occur in the brain. Studies of large series of normal adults have shown that about 90 per cent of such individuals have variations in the electrical potential of the brain tissue at a rate of 8 to 12 per second with a voltage of 10 to 100 microvolts. These variations have been given the name of "brain waves". They change with age, physiological states, sleep and in certain pathological conditions.

The most interesting changes found in electroencephalograms are found in epileptics. About 85 to 90 per cent of persons having petit mal epilepsy show abnormal electroencephalograms. Many of these patients show outbursts of high voltage three per second spike and wave complexes. Seventy-five per cent of patients suffering from generalized seizures, grand mal, show either very fast frequencies (15 to 30 per second) of increased voltage or very slow wave forms (less than eight per second). Often an epileptic will show both very fast and very slow waves with spike and wave conplexes. Patients who have myoclonic epilepsy have high voltage two to three per second spike and wave complexes. Space occupying lesions, tumors, abscesses or subdural hematomas frequently produce localized areas of very slow waves or suppression of the normal electrical activity of the brain. Those patients that have psychomotor seizures frequently show slow waves of a moderately increased amplitude at the rate of about 5 to 6 per second. However, they may show faster or slower wave forms at times with the abnormality more marked in the frontal and temporal regions. Autonomic seizures which give the appearance of anxiety attacks show outbursts of slow waves. Recently at this hospital the electroencephalogram revealed abnormalities in a 37 year old woman who complained of sudden periods of chills, feelings of warmth, dizziness, and sweating. These were often precipi-

tated by arguments with her husband. Her electroencephalogram showed outbursts of increased voltage 5 to 6 per second waves, more marked when the recordings were made between the temporal regions or ears. The patient has been placed on tridione. It is too early as yet to decide if this medication is helping the patient.

Considerable variation exists in the electroencephalograms following head injury. In general, however, there is a definite correlation between the severity of the head injury, the period of amnesia, the presence of bloody spinal fluid, fractures of the skull and the degree of abnormality found in the electroencephalogram. This abnormality, which is most marked at the time of the injury, tends to reverse back to the normal as the clinical signs and symptoms clear up.

Results obtained in the study of epileptics and space occupying lesions at the U. S. Naval Hospital are shown in Table No. 8 and Table No. 9.

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Table No. 1

Median Nerve Injury

Days after injury	Opponens pollicis (chronaxie)	Abductor pollicis brevis (chronaxie)
91	54	29
96 Suture		
102	54	40
130	54	40
141	14	14
153	5	5
173	2	2
204	2	1

Table No. 2

Ulnar Nerve Injury

Days after injury	1st Dorsal Interosseous	Abductor digiti V
2	Less than 1	Less than 1
8 Suture		
10	14	10
22	20	29
38	29	20
62		10
76	20	1.5
96	1 to 1.5	Less than 1

Table No. 3

Ulnar Nerve Injury

Days after injury	Abductor digiti V	1st Dorsal interosseous
54	54	75
56 Suture		
68	54	75
89	54	75
106	54	14
116	10	5
128	10	1.5 to 1
150	?	Less than 1

Table No. 4

Strength Duration Curves

Milliseconds	Abductor digiti V (normal)	Abductor digiti V (Abnormal)	Abductor digiti V (abnormal)
300	4.5 ma	3 ma	6 ma
100	4.5 ma	3 ma	6 ma
75	4.5 ma	3 ma	6 ma
40	4.5 ma	4 ma	6 ma
29	4.5 ma	5.5 ma	8.5 ma
20	4.5 ma	9.5 ma	8.5 ma
14	4.5 ma	25 ma	8.5 ma
10	4.5 ma		8.5 ma
7	4.5 ma		19 ma
5	4.5 ma		19 ma
3	4.5 ma		25 ma
2	4.5 ma		
1.5	5 ma		
1	5.5 ma		

Table No. 5

Galvanic Tetanus Ratio

Days after injury	Extensor hallucis longus (tetanus ratio)	Tibialis anticus (tetanus ratio)
42	1.1	1.1
53 Suture		
64	1.1	1.2
80	1.5	1.1
95	1.2	5.6
103	3.5	6.5
121	7.5	8.8

Table No. 6

Galvanic Tetanus Ratio

Days after injury	1st Dorsal Interosseous (tetanus ratio)	Abductor digiti V (tetanus ratio)
11	3.8	3.1
20	4.2	4.5
32	1.1	1.5
42 Suture		
51	1.2	1.1
63	1.1	1.1
76	1.1	1.8
87	3.1	7
101	7.6	10 ?

Table No. 7

Galvanic Tetanus Ratio

Days after injury	Abductor digiti V (tetanus ratio)	1st Dorsal Interosseous (tetanus ratio)
4	3	4.8
5 Suture		
23	3.4	4.8
34	4.8	4.1
69	1.4	1.8
84	1.3	1.3

Table No. 8

Type of Epilepsy	No. of Cases	Normal	Abnormal
Grand mal	401	56 (14%)	345 (86%)
Petit mal	12	0	12
Psychomotor	17	0	17
Myoclonic	1	0	1

Table No. 9

Space Occupying Lesions

Supratentorial	No. of Cases	Correct	Wrong Area	No Localization
Neoplasm	59	49	4	6
Subdural	8	7	2	1
Abscess	2	2	0	0
Subtentorial				
Neoplasm	2	0	0	0
Abscess	1	0	0	0

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III. GOSSIP

This is the Commencement time. This all-American custom started when parents and friends of graduates thought they should do something about the finish of school. They petitioned school authorities to change commencement from the beginning of the school year to the end. Instead of it being a private custom in connection with the opening of the school, they made it a public affair at the close. During the war commencement trips were fewer because of transportation problems, but this year I took on a few. May 23rd I spoke at the Ancker Hospital exercises for the nurses. The class was smaller than usual and future prospects did not look good. Music has become the dominant extra-curricular activity in most schools. The nurses' chorus at Ancker is unusually good. The preacher who opened was a fine fellow. He confided to me he had been a wrestler and professional baseball player in his student days. Following the ceremony we went to the nurses' home for coffee and---. The place was spotless and attractively arranged. I visited the quarters of Superintendent Thomas E. Broadie and family who had dressed up to go across the hall. Dr. Broadie fills the shoes of his predecessors very well....Saturday, May 24th, the medical veterans at the Center had their picnic at Interstate Park. They are at that productive stage in which baby carriage parades dominate the scene. In the evening the ashes were dug away from the rare roast beef which had been cooking all day. Enormous pots of baked beans were pulled from the ashes and the party was on. Early that morning a large pit had been dug, lined with boulders. A roaring wood fire heated the stones and the meat was buried in the ashes. An untimely rain interfered at a lage hour but everyone had a perfect day...On May 28th, to speak at Groveland School at an 8th grade graduating exercise. The music was lusty but colorful. The graduates varied enormously in size. Through coincidence or design, a long, lean fellow would be followed by a short squirt. Most entertaining were the big grins on the young athletes' faces when they received their letters...May 29th, I spoke at Excelsior High School. This is a Cap and Gown affair and the music is near professional in quality. The valedictorian whom everyone knew as Jim walked away with as many prizes as if he had been on a radio program. He won the usual scholarship to a Minnesota college, the Readers' Digest for a year, and a set of books. In addition he won a cash award in a Pepsi-cola contest, a letter in athletics, honorary writing award, and a flock of awards for examinations in which he competed. The most impressive was placing in the first ten among graduates over 2,000 high schools. (The only man from Minnesota to qualify.) A girl was salutatorian. The ushers wore summer formals. It is from high schools such as this that top-notch students are sent to the Universities and colleges.....Sunday, June 2nd, to St. Mary's College commencement in Winona. 50 men graduated. They were a combination of veterans and civilians. Some started their work 8 or 9 years ago and the war had interrupted. The music here was outstanding....High school commencements are the easiest to address, college the most serious. A group of nuns had just flown in from Holland on their way around the U.S. to visit their houses in this country. They spoke perfect Oxford English and had a remarkable grasp of medical and hospital organization. Here I learned how to put on a McSorley steakfry. The participants are clothed in long aprons. When the coals are just right, the meat is broiled and cut into strips which are placed on hard bread soaked in barbecue sauce. The mixture is washed down with mugs of cold beer. The purpose of the apron is to wipe your hands and face on it as the party progresses....At St. Catherines College for Women, June 2nd. Here the ranks of young women in Cap and Gown are notable for the number who have dark hair (black Irish, Scotch, German, etc.). In the final ceremony of the day (Benediction) the young graduates are led from the church by two young ladies carrying American beauty roses. They sing a beautiful hymn, but as soon as the church door is past they break out with their college song. Parkers' Prairie high school, Woodrow Wilson high school in St. Paul and University commencement remain on my list. There is something inspiring in all of this. It is interesting to watch the expressions on the graduates' faces as they reach this important milestone in their life.....