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University of Minnesota Medical Bulletin

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Staff Meeting Report

Acute Mechanical Intestinal Obstruction

A Study of 346 Cases*

Earl Y. Bickel, M.D.,[1] Grafton A. Smith, M.D.,[2] and
L. Stephen Richards, M.D.,[3]

For the past 25 years, this clinic has been strongly interested in obstruction of the bowel. Treatment by intestinal suction was first reported in 1931, when three cases were described. This was followed by unrelenting efforts to determine the physiologic and lethal factors of bowel distention. The pioneer view of Wangensteen and associates that death results from mechanical effects of distention has definitely modified the surgical management of obstruction.

This progress report deals with attempts to apply these newer concepts. Results of treatment and causes of death were analyzed for all mechanical intestinal obstructions seen at the University of Minnesota Hospitals from September 1, 1953, through December 31, 1955. A total of 304 patients represented 346 cases, 39 of the group having two or three episodes of obstruction apiece.

The diagnosis was made by history, physical examination, and radiography, sometimes verified by surgery or necropsy. Excluded from the study were patients with (a) adynamic and postoperative ileus, (b) chronic obstruction without roentgenography evidence of distention or blockage at the time of surgery, (c) partial stricture of the colon without proximal distention, or (d) mesenteric thrombosis.

Nearly 70% of attacks were due to five of the 21 causes, in this order of frequency: postoperative adhesions, compression neoplasm, neoplastic stricture, external hernia, and operative complications. Among other mechanisms were inflammatory adhesions, spastic ileus, volvulus, intussusception, and megacolon.

Almost half of the subjects were 60 years of age or older. Babies under the age of one year, who represented 9.1% of obstructions, frequently had congenital atresia, imperforate anus, postoperative adhesions, and surgical complications, such as anastomotic stricture.

*This is an abstract of a report given at the Staff Meeting of the University of Minnesota Hospitals on May 25, 1956. A copy of the complete report, including tables and references, may be obtained by writing to the Editor, UNIVERSITY OF MINNESOTA MEDICAL BULLETIN, 1342 Mayo Memorial, Minneapolis 14, Minn.

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[3]Medical Fellow, Department of Surgery.

Fatalities from all causes totaled 41, but 20 were due to preexisting diseases and were therefore excluded from analysis. The case mortality from obstruction was 6.5%, and 7.4% of the patients succumbed. Peritonitis was associated with 76% of deaths, postoperative peritonitis and unrecognized obstruction being the major factors.

Mortality may be considerably influenced by the cause, type, and site of blockade and also by distention of the bowel, age, and sex. Among causes of obstruction, congenital atresia was most dangerous, with a death rate of 28.5%. Malignant lesions came next, with 14.3% fatality, then operative complications, volvulus, and postoperative adhesions, each rating less than 10%.

Comparing types of occlusion, the mortality rate was low unless viability of the bowel was impaired. Perforations with gangrene caused 10 times as many deaths as simple nonperforated lesions or strangulating but nongangrenous conditions.

As for site, simple obstruction with perforation was decidedly more hazardous in the large bowel, being fatal in two-thirds of cases, probably because of bacterial contamination. However, a gangrenous perforated small intestine with extensive peritoneal soilage approached the deadly effects of colic rupture. Severe distention nearly doubled mortality over that for moderate and slight degrees.

Age was important, since the very old and the very young tolerated obstruction poorly. Of patients over 79 years of age, 15.4% died, and of those under one year, 9.1%, whereas between those ages, the mortality rate was only 5.2%. Sex and mortality may not always be correlated. In our series, however, 16 of 188 men, or 8.5%, but only 5 of 138 women, or 3.6%, died.

Analysis of treatment also excluded the 20 subjects with death not related to hospital care of obstruction. Large and small bowel were considered separately and also, because of dissimilar factors, children under the age of 10 years and the older group.

Treatment of lesions in the large and small intestine had comparable over-all results. Outcome was best in nonoperative cases, where the only three deaths were due to unrecognized obstruction and lack of appropriate treatment. In the surgical group, results were best with operation undertaken in the first 24 hours after admission or diagnosis.

Small bowel obstruction was managed in various ways. As soon as distention was found, a gastric or long intestinal tube was passed. If a trial of suction was proposed, the possibility of strangulation or gangrene was investigated with meticulous care.

Manifestations definitely more common with gangrenous than with simple obstruction were tenderness, with respective rates of 87 and 45%; rebound tenderness, 50 and 11%; decreased to absent bowel sounds, 51 and 22%; and temperature above 100° F., 45 and 21%. Either simple or strangulated blockade produced white cell counts over 10,000 in 41% of cases.

When signs of strangulation or gangrene were recognized, operation was done at once. During a trial of suction, the clinical, laboratory, and roentgen findings were assessed frequently. If obstruction abated or distention improved within twelve hours, surgery was delayed. As a rule, those failing to gain or showing evidence of impending gangrene or perforation were operated on immediately.

Only one patient less than 10 years of age with small bowel obstruction was treated nonsurgically, in contrast to 32% of adults. Accordingly, just the older group is considered here.

Trial of suction and early operation seemed almost equally effective, on the whole. However, the surgical death rate was 1.7% with early and 10% with delayed intervention. Surgery was undertaken in 119 cases of blocked small intestine, and bowel was resected in 58 cases. No deaths occurred without resection, whereas mortality after excision was 10.8%. When previously viable segments of bowel were removed, the rate was 5%.

Large bowel obstructions generally required prompt surgery, but 15.5% of our cases were managed nonoperatively. Most of the nonsurgical lesions consisted of sigmoid volvulus, low-lying obstruction, low anastomosis obstruction, fecal impaction, and anorectal stricture. All were handled successfully with the aid of a proctoscope, rectal tube, and enemas.

Frequently, the colon was not strangulated, and therepeutic results were closely related to the amount of distention. When this was severe, primary resection was fatal in 20% of cases but caused no deaths with moderate to slight distention. Average mortality rate was 28.6% for cecostomy, 6.9% for primary resection, and 5% for transverse colostomy.

Management of intestinal obstruction was also evaluated by comparing results for two periods, 1942-53 and 1953-56. Improvement was expected from antibiotic therapy in instances of gangrenous and perforated lesions, yet the newer agents were no more protective than previous measures for the following reasons; unrecognized obstruction or gangrene in four patients, fatal resection of a badly distended large bowel in two patients, and fatal delay in surgery of

right colic cancer in 2 subjects. Otherwise, mortality from obstruction would have been only 4.4%.

Since gangrene and perforation were major factors in demise, symptoms suggesting strangulation require prompt surgery. To aid diagnosis, pneumoperitoneograms are now being made on suspicion of early strangulation. So far, the information obtained has proved rewarding, especially when the routine abdominal films have shown little gas in the small bowel.

Most important, of course, is to suspect obstruction and request proper radiographic examination. The usually fatal perforations of the colon are generally associated with severe distention, which is best relieved by early transverse colostomy.

Schatten reported that intraperitoneal antibiotics are of real value for acute bacterial peritonitis. This agrees with the views of our clinic that intraluminal antibiotics might be helpful when injected through the long intestinal tube at operation after decompression of proximal bowel and during the postoperative period.

For infants, the chief problem is congenital atresia with nonfunction of the bowel anastomosis after surgery. Louw and Barnard have secured evidence that atresia may result from local interference with the blood supply to the fetal bowel, and therefore they advised removing sections of bowel both proximal and distal to the narrow segment to restore circulation and function. Wangensteen's plan of a proximal decompressive enterostomy and a distal opening for feeding has been successfuly used at our clinic.

The many recent advances in surgery permit more frequent definitive procedures on the distended obstructed small bowel. At operation, the best means of relief is intubation, using a stylet to propel the tube into the bowel. If this procedure is impossible, aseptic decompressive enterostomy is helpful. Both technics have been used widely and are essentially non-hazardous. With these adjuncts to reduce distention, operation should be early in all cases with evidence of strangulation obstruction.

Finally, a trial of intestinal suction should be reserved for small bowel obstruction without signs of strangulation. The bowel is intubated rapidly, and, twelve hours later, the patient's status is carefully reviewed by physical and roentgen examination of the abdomen. If the condition progressively improves, suction is continued. If the obstruction has not relented in 36 to 48 hours, suction is stopped and operation is done. During decompression by suction, regular walking should be prescribed to aid descent of the catheter and to lessen the considerable risk of pulmonary embolism.

Staff Meeting Report

Trends in Trauma*

M. Soe Thein, M.D.,[1]

Injury is one of the most frequent causes of disability in this atomic age. Moreover, serious damage is common in a highly mechanized society. As the forces producing trauma become greater and more complex, the patient's wounds become more numerous and more complicated. Outcome depends to a large extent upon the initial care that the patient receives. While conditions that endanger life must have priority, other crippling lesions cannot be neglected.

This study was undertaken to observe the changes in the management of fractures and other injuries at the University Hospitals in the past three decades, to determine whether types or mechanisms of injury have altered, and, finally, to see whether our methods of treatment have become more effective. Records of 300 cases of fractures, excluding only those of the skull and facial bones, were taken from hospital files. Groups of 100 cases observed in 1935, 1945, and 1955 showed thereapy before use of antibiotics, shortly after their introduction, and at present.

Changes in the way we live and work are reflected in causes of accidents. Mishaps on the farm and in industry have sharply decreased, no doubt because of safety devices and safety education. Home and highway accidents continue to be mainly responsible for fractures.

Fractures are becoming more prevalent among women, probably owing to wider employment and activity of women. Also more people in the elderly group are being injured; 22 of 100 patients were beyond the age of 65 years in 1935 and 36 of 100 in 1955. The proportion will continue to increase with an aging population.

Nothing in our history has prepared us for the destructiveness of high-powered automobiles and other machines. The number of

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*This is an abstract of a report given at the Staff Meeting of the University of Minnesota Hospitals on June 1, 1956. A copy of the complete report, including tables, may be obtained by writing to the Editor, UNIVERSITY OF MINNESOTA MEDICAL BULLETIN, 1342 Mayo Memorial, Minneapolis 14, Minn.

[1]Medical Fellow, Division of Orthopedic Surgery, and Captain, Burmese Army Medical Corps.

subjects with multiple fractures has doubled from 1935 to 1955, and additional soft-tissue wounds have become more frequent. Multiple lesions pose intricate problems in management.

More people are now treated by operation. For example, all of 37 femoral fractures were handled conservatively in 1935, but only 2 of 30 in 1955. Just 7% of all cases reviewed in 1935 were surgical, but 36% were operated upon in 1955.

The less severely injured now recover faster than formerly; 30% of subjects in 1935 and 43% in 1955 stayed in the hospital only a week or less. The number of persons requiring more than four weeks of institutional care is essentially unchanged, however.

To illustrate alterations in management, one case from each period is presented.

Case 1 (1935). This 32-year-old man was admitted to University Hospitals shortly after being struck by a hit-and-run driver. He appeared to be quite confused. His skin was cold and moist, and his pulse was 120. There was pain on movement of both lower limbs and visible deformities in the thighs. Roentgenographic examination showed a fracture of the right femur at the junction of the middle and lower thirds and of the left femur at the midportion.

The patient was treated with Thomas splints, with skeletal traction through the distal femurs and Kirschner wires were inserted under ether anesthesia. Reduction of the fractures was satisfactory. Two weeks later, the first of four double spica plaster dressings was applied.

The man recovered very slowly from his head injury. After eight weeks of hospitalization, he was discharged. Immobilization in the plaster spica was maintained for three months, and the patient had satisfactory union of the fractures at the end of six months.

Case 2 (1945). This 57-year-old man fell from the second floor to the first floor of the building upon which he was working, landing upon his right leg and falling backward. He was struck on the forehead by the hammer he was holding in his hand and incurred some lacerations, which were debrided, sprinkled with sulfa powder, and sutured by his local physician.

The patient also had a fracture of the distal end of the right femur and the lower portion of the right tibia and fibula. The leg was supported by a Thomas splint, and the man was sent to the hospital.

Under cyclopropane anesthesia, the fractures were reduced, and the limb was placed in a plaster spica. Two weeks later, in order to

improve the position of the fragments, open reduction and internal fixation with screws and wire were performed. Penicillin and sulfadiazine were given postoperatively as prophylaxis against infection.

The patient remained in a plaster spica for six months; at the end of this time, union of the fractures had occurred. Physiotherapy was then used to help the man regain knee motion.

Case 3 (1955). This obese 17-year-old girl was brought to University Hospitals three hours after being crushed between two cars in an automobile accident. She had an open fracture of the middle third of the left tibia and fibula and a closed fracture of the middle third of the femur on the same side. Across the upper end of the thigh was a laceration extending from the perineum to beyond the anterosuperior spine of the ileum. A large amount of fat was protruding through this wound.

The patient was in shock, with blood pressure of 90/40 and pulse of 140. She was given 1,500 cc. of whole blood immediately. A prophylactic dose of tetanus antitoxin was administered.

Using Sodium Pentothal as an anesthetic, the wounds were cleaned and debrided. The fracture of the tiba was fixed with two transfixion screws. Because of the large amount of damage to the skin and subcutaneous tissue of the thigh, the femoral fracture was treated conservatively by means of skeletal traction. The soft-tissue wound on the thigh consisted of complete undermining of the skin and disruption of the subcutaneous fat. Postoperatively, the leg was suspended on a splint.

During the next ten days, the skin over the entire thigh sloughed away. After several debridement procedures, grafting with split-thickness postage-stamp grafts was started. During this period penicillin, streptomycin, and erythromycin were given to combat infection. Grafting was successful.

After five months of hospitalization, the patient was discharged from the hospital wearing an ischial weightbearing brace. At the end of nine months, she had returned to work as a secretary with a normal range of motion in the knee.

Staff Meeting Report

History of the Radiation Therapy Section

K. W. Stenstrom, Ph.D.[1]

Introduction

Let us first consider the early development of radiation thearapy. After Roentgen's discovery and study of x-rays in 1895, it did not take more than a few months before the new rays were used for treatments of certain skin diseases. Then followed the discovery of radium by the Curies in 1898. It soon was noticed that the rays from radium as well as x-rays had destructive effects on tissues and it was therefore assumed that they might be used for treatment of cancer. After the inevitable fluctuations between enthusiasm and disappointments, a more reasonable attitude was adopted concerning the effectiveness of the rays. The first successful treatment of a skin cancer with x-rays was obtained in 1899 by Stenbeck in Sweden.

Radium was soon found to be particularly useful for treatment of cancer of the uterine cervix as well as for tumors which could be reached and implanted with radium needles. The main limitation for treatments with x-rays was their slight penetrability due to the relatively low voltage available. It became evident that machines delivering higher voltages were needed and such machines were developed in Germany in 1914. Two German physicists, F. Dessauer and W. Friedrich, contributed greatly to put roentgen therapy on a sound basis by means of careful measurements of the absorption and distribution of the rays. When the First World War was ended it became known that 200 kv x-ray therapy had been successfully used in Germany. A book published by Seitz and Wintz demonstrated that remarkable results could be obtained.

Radium and low voltage x-rays had in the meantime been used in the United States by a great number of physicians with considerable success. When it became known that 200 kv x-rays had extended the usefulness of roentgen therapy, the interest became great in this country. Under the leadership of William Coolidge, both machines and

*This is a report given at the Staff Meeting of the University of Minnesota Hospitals on June 8, 1956.

[1]Professor of Biophysics and Director of Radiation Therapy.

x-ray tubes suitable for such therapy were perfected by the General Electric Company. I had the opportunity to standardize the first of the new machines at the State Institute for the Study of Malignant Disease in Buffalo, New York (now Roswell Park Memorial Hospital). With the help of a German physician, H. Holfelder, who was in charge of the roentgen therapy at the University of Frankfort, the treatment of patients with this new machine was then started in 1921.

The Cancer Institute

The possibility of treatments of cancer patients with radiation stirred up a great interest at many places. At the University of Minnesota, new action was taken when the George Chase Christian Memorial Donation was received by the Medical School in 1925. At that time, E. P. Lyon was dean and head of Physiology, Dr. Baldwin was superintendent of the hospital, and Dr. Arthur Strachauer was chief of surgery. Under their direction a Cancer Institute was initiated. The east wing of the hospital was erected and the Christian fund was used for a major portion of this structure and for acquisition of radium and a 200 kv x-ray machine.

In the new building there were fifty beds for cancer patients and a separate out-patient clinic on the second floor with a large reception room (the present physics laboratory), an office and record room. There were three examining rooms, a tissue laboratory and an office suite for the director. The x-ray machine was installed in a large, specially constructed, therapy room joining a control room. Another room housed a radon plant with one-half gram of radium in solution. A total of 200 mg. of radium in tubes, needles and plaques was also stored in a separate safe. The Institute was completed in 1925.

When the radon first was used, some disastrous experiences resulted which made it evident that a physicist was needed to help with the measurements, the planning of treatments, and the calculations. I was invited to visit the University to give advice and was offered a position as associate professor of Biophysics in the Department of Physiology with the main duty of supervising the radium and the x-ray machine.

When I arrived in July, 1926, the use of radon had been discontinued and the 200 kv x-ray machine was standing idle. Dr. Robert Allison was in charge of radiology but had refused to touch the new powerful x-ray machine. He asked me to supervise the treatments on his responsibility and when the other staff members also insisted

on this arrangement, we started to treat patients after the machine had been standardized and supplied with an ionization monitoring chamber. To check the amount of stray radiation and the exposure to the personnel, measurements were made with ionization chamber and dental film badges were used and compared with similar films exposed to known amounts of irradiation. The radon and the radium was soon also in full use. The only full time fellow in Radiology at the time was Milton Geyman, and he was assigned to spend a couple of hours each day to help with the treatments. A nurse was made available part time to care for the patients and to watch the machine.

Dr. Strachauer was director of the Cancer Institute as well as head of the Department of Surgery when the out-patient clinic was opened in 1926. The first surgeon to run the clinic was Dr. O. J. Campbell and the following year this responsibility was taken over by Dr. William Peyton. The radiation therapy section was represented in the clinic from the start and has always had someone in attendance since that time at the cancer clinic.

Dr. Strachauer retired from the chairmanship of the Department of Surgery in 1930 but remained director of the Cancer Institute while Dr. Owen Wangensteen was appointed chief of Surgery. Dr. William O'Brien was pathologist in the Cancer Institute.

A change in the organization was made when Dr. Strachauer resigned from the Cancer Institute. The clinic was transferred to the Department of Surgery and a Cancer Institute Board was appointed by the Dean. Radiology was made a separate department in 1937 with Dr. Rigler as head and radiation therapy became a section of this department.

Radiation Therapy

Radiation therapy expanded rapidly. "Superficial therapy" was first carried out in the diagnostic section but it soon became necessary to have a separate unit for these treatments and an old 140 kv machine was transferred and installed next to the other therapy room. The deep therapy machine was utilized to its full capacity and, by 1938, all the requests for treatments could not be accepted, but a certain amount of selection had to be made. Appointments were scheduled for up to one month in advance. At that time, Mrs. Christian supplied money from the Citizen's Aid Society for a second high voltage therapy machine, and in 1942, she agreed to finance the replacement of the original 200 kv machine with a 400 kv machine. In the meantime the University had replaced the old "superficial

therapy" machine with a new portable 140 kv machine and had added a Phillips contact therapy unit. When the Mayo Memorial was erected, an underground addition was built for the radiation therapy section and it was planned to house the radium, the radon plant, a radio-isotope laboratory, a Cobalt^{60} beam therapy machine and a multimillion volt x-ray therapy unit. It was very fortunate that Mrs. Archie Walker became interested in cancer therapy and generously decided to donate the funds necessary to acquire and install a 1000 curie source of Cobalt^{60} in the large machine necessary for the operation. Thus the second unit of this type to be used for cancer therapy in the United States was put into operation in April, 1953.

The x-ray, radium and Cobalt^{60} therapy represents a significant portion of the activities in our section, but it is only one of several functions. Teaching, research and development of other applications of medical physics were important fields.

Physical Therapy

At the time the section was started (1926), no physical medicine was available at the Hospital. The only sign of a beginning along this line was the use of ultraviolet light. Two mercury quartz lamps had been acquired. One belonged to Pediatrics and one to Dermatology. They were used occasionally but without any type of standardization. It was suggested that they be turned over the the radiation therapy section. It thus became my duty to standardize these lamps and determine the proper dosage for the treatments. A nurse had to be assigned to this work and had to be trained. It was evident that she could handle more equipment and it seemed advisable to add a heat lamp. The application of heat soon became more important, and in order to supply heat to deeper structures we added a diathermy machine. Then it became necessary to study the heat distribution in the tissues and a series of investigations were made. Many peculiar ideas about the action of the high frequency current from the diathermy machine were in vogue and physicians were told by so-called experts that certain frequencies were needed to treat certain diseases. The textbooks were full of errors in regard to the physical characteristics of high frequency currents. A thorough investigation was needed. Fortunately, Allan Hemingway was willing to undertake such research for his Ph.D. thesis. This laid a sound foundation for the medical applications of the high frequency currents. We were asked to write a special article for the J.A.M.A. and the mystery was taken out of diathermy machines.

As superintendent of the University Hospitals at that time, Mr. Paul Fesler became interested in physical therapy and helped us with space. The first physical therapy quarters were in the basement, next to the morgue. Six small booths had been partitioned there. After a couple of years they were moved to the south end of the first floor. This was a great improvement with daylight and fine metal partitions. Eventually, the quarters were established in the first floor of the Eustis wing where, among other things, a nice swimming pool had been installed. Then hydrotherapy was, of course, added as a routine method. Massage had been introduced previously with the assistance of a masseur who volunteered to spend a few hours weekly in the section. Dr. Cole wanted, however, to have a full time assistant for this important work and assigned funds for the employment of a masseuse (Miss Sara Kollman). When the first experiments with hyperthermia or fever therapy seemed to indicate its usefulness for treatments of general paresis and gonococcal infection, we started to apply this method by means of diathermy. Later on, a Kettering high temperature box was obtained and Dr. Cook was assigned to develop the method further.

The interest in physical therapy grew rapidly and it gradually became an accepted form as a medical specialty. Dr. Miland Knapp was the first physician to enter this field in Minneapolis. He was appointed a member of the medical staff and became a director of the physical therapy section. Later on, Dr. Frederic J. Kottke took over as a full time member. Under his direction, the activities expanded and rose to greater heights and a separate department of Physical Medicine was born.

Isotopes

Among the new activities which were developed in the Radiation Therapy Section, the use of radioactive isotopes is of special interest. The first small amounts were made available by the Physics Department after the 4,00,000 volt Van de Graaf electrostatic generator had been activated in 1940. Sodium^{24} and Chlorine^{38} were obtained for experimental work and suitable measuring equipment was constructed. We were, therefore, ready to start with clinical application of Iodine^{131} and Phosphorus^{32} when adequate amounts of these isotopes could be obtained from Massachusetts Institute of Technology and from the University of California in 1945. When larger amounts were made available at Oak Ridge, enough experience had been obtained so that routine uptake studies could be established for determinations

of thyroid gland activity. The therapy of hyperthyroid patients with I^{131} and polycythemia vera patients with P^{32} was also put on a rotuine basis. The laboratory was fully equipped with suitable measuring instruments, apparatus and chemicals and research with a number of other radioactive isotopes was initiated.

The danger of too much exposure of the personnel to radiation was appreciated from the beginning and adequate safeguards were established. Radiation meters of suitable sensitivity were used and a film badge service was instituted so that the amount of exposure could be measured and kept below the upper limit of safety. We already had safeguards when the president appropriated money to the university committee for radiation protection on the campus. The supervision of the program was, for that reason, turned over to the radiation therapy section and a safety technician was employed. When the program expanded further it was transferred to the Health Service Department.

Teaching

The increased application of physical methods and physical apparatus in the medical field made it advisable to include biophysics in the medical curriculum. It also was necessary for the students to acquire some knowledge about the usefulness of radiation therapy. A lecture course covering these fields was started in 1927 but because of the crowded curriculum it had to be limited to 12 hours. The cancer clinic offered the students an opportunity to observe the selection of patients for radiation therapy as well as the reactions and results obtained with this type of treatment. The teaching has been gradually expanded and it now includes 12 hours of biophysics in the sophomore year, 14 hours of x-ray physics and radiation therapy in the junior year and 3 hours of review in the senior year. It also includes observation in the cancer clinic and discussions during the cancer conference and three hours of visits in small groups to the department for instruction and observation of treatments.

Fellows in Radiology spend 9 months to one year in the section and partake in all the activities, including weekly lectures and conferences. They receive special instruction in the physics of Radiology and enough experience with x-ray and radium therapy and the clinical application of radioactive isotopes to take the national board examination in the respective divisions of radiology.

Opportunities for physicists and students in related fields to register for laboratory work in biophysics in the hospital have been avail-

able since 1927. Relatively few students have been attracted to this field due to the lack of satisfactory positions in biophysics in the medical schools. A small number have carried out work for their Ph.D. theses in the laboratory and have obtained their degree in biophysics, physics or biochemistry. These include Carl Nurnberger, Allen Hemingway, Earl Arnow, James Marvin, Jun Chuan Wang and C. Gasteiger. Others have taken more limited course work. A number of the fellows in radiology have also carried out thesis work for Ph.D. or M.S. degrees.

As radiation therapy is devoted mainly to treatments of cancer patients it is evident that the teaching also includes the cancer field. Continuous instructions are given in the proper selection of patients for this type of therapy as well as in the details of suitable irradiation methods. The cancer conferences are of special benefit for both medical clerks and fellows. A cancer fellowship has been made available by the American Cancer Society for a number of years.

Research

It was the opportunity for research which persuaded me to accept the staff position at the medical school here in 1926. The first major equipment obtained was a 200 kv cathode ray machine. W. Coolidge had just developed a high voltage cathode ray tube. Only a few of these tubes were made for research purposes and we were permitted to buy one of them at a nominal cost. It was a rather dangerous radiation source to play with as a strong and wide beam of electrons emerged into the air and scattered around in a half circle outside the window of the tube. Though reasonable precautions were taken and lead protection was used, it is possible that the exposure to the operator was considerably above the present day safety limits. No satisfactory standards were available at that time. Perhaps it was fortunate that shortage of space made it necessary to dismantle the machine and interrupt the studies. Enough experience had been obtained with exposure of rabbit's ears to demonstrate the epilation effect, the production of necrosis to a depth of about one mm., and the generalized effect on the leukocyte count. At that time, the importance of vitamin D had been discovered and its production from ergosterol by ultraviolet light had been emphasized by Steenbock. We found that cathode rays both produced and destroyed this vitamin but the effect was quantitatively insignificant.

The plan was to study the effect of cathode rays on certain types of skin diseases. The dermatologists had agreed to select some suitable

patients but evidently they never found any. At least they did not refer a single one for the experiment. A patient with a superficial epithelioma was, however, willing to try the new treatment method. He was placed in front of the tube and was well shielded with just the lesion exposed. The switch was turned on and the patient jumped off the platform with a yell. The intensity of the electron beam was great enough to produce a heat sensation and an electric shock. The epithelioma was not destroyed as the dose was too small. The intensity could, of course, be reduced but no further patients were available before the machine had to be dismantled.

Research expanded into several fields. The investigation of the diathermy machine has already been mentioned. Measurements of cutaneous, subcutaneous, muscle, oral and rectal temperatures were carried out before and during heat application and recording instruments constructed so that 24 hour temperature records could be made. The effect of ultra-violet irradiation was studied in regard to effect on skin, wound healing, etc. and on bacterial cultures.

When the University acquired an electron microscope it became our task to do the preliminary work and to supervise its use. Marvin investigated different staining methods for shadow casting and investigated pore structure of model membranes for his thesis. More recently he has been investigating the effect of irradiation of cell membranes.

Radiation therapy has been developed empirically. It is therefore necessary to evaluate the results while the methods are gradually improved. Such clinical studies have been going on continually. Real progress in this field requires, however, fundamental knowledge about the action of ionizing radiation and the most consistant and important research has been devoted to such investigations from the start and up to the present time.

Ionization measurements were carried out to determine the distribution of the radiation. Water-phantoms, wax models and pressed wood blocks were used as soft tissue equivalents and parts of skeletons for bone structures. For determination of ionization in bone, small bone chambers were made and measurements performed with different qualities of x-rays. Important wavelength dependence was found; the soft radiation increasing the ionization several-fold while the penetrating rays showed little increase of the ionization above that in the soft tissues.

The inhibition of bone growth in young rabbits after irradiation of the epiphysis was studied and found to be proportional to the dose,

with a measurable effect from an exposure to 400 roentgens.

Irradiation of weak aqueous solutions of organic compounds leads to interesting findings. The main primary effect on the water molecules produced oxidation of the solute molecules. It seemed that any type of organic compounds could be changed in proportion to the amount of primary ionization produced. Competition between different types of molecules occured in a mixed solution. Fortunately, much of this work could be carried out cheaply as very little money was available for its support. The x-ray tube was at that time installed in a large lead-covered drum and the material to be irradiated could be left inside the tube stand while patients were being treated. It was found that certain colored solutions, such as those of methylene blue, faded during irradiation. The color change was calibrated against x-ray dose by means of a spectrophotometer. It could then in turn be used for irradiation measurements. Certain liquid hydrocarbons were also irradiated. Only a very small proportion of the molecules would be ionized by the amount of x-rays used for the exposure but by means of sensitive detection methods it was found that oxidation was produced and that small amounts of explosive gases were liberated. Unsaturation was also produced and this was the main effect discovered when oxygen was excluded. The findings included evidence of polymerization as well as depolymerization. The effect on aqueous solutions as well as on water-free organic molecules indicate that ionizing radiation must influence tissue constituents in both manners. These types of experiments indicate that a great variety of chemical reactions take place in tissues when they are exposed to ionizing radiation. It occurs inside the cells as well as in the body fluids: intracellular, extracellular, blood, lymph and secretions. Which reactions are of predominant importance? Is the direct effect on certain structures such as the chromosomes and genes the deciding factor or may the indirect effect, oxidation or reduction of certain enzymes be of greater importance? As at least 80% of tissues consist of water it can be concluded that about that proportion of the primary ionization occurs in the water molecules and this effect can certainly not be negligible. It is a formidable task to determine the important chemical reactions. Some of them can, however, be studied by means of radioactive isotopes. The obtainable facts may not only give information about the action of radiation but may also lead to some forms of chemical therapy and may be of biochemical and physiological importance. Investigations along these lines by Vermund and Barnum have already yielded considerable information in regard to the in-

fluence on nucleic acid formation in mouse mammary carcinoma by *in vivo* irradiation. Other studies are in progress at the present time.

Among the methods used to collect information has been included irradiation of lymphocytes in tissue cultures. Dr. Joseph King and his associates supplied the cultures and studied the effect. It was proved that irradiation with 20 roentgens produced a measurable inhibition of migration while a dose of 40,000 roentgens was required to eliminate ameboid cells 24 hours after the exposure.

The inhibition of tumor growth and the eradication of tumors by means of radiation may to some extent be caused by direct action on the malignant cells but it is also influenced by the interaction between the "tumor bed" and the cancer cells. It seemed that investigations of the importance of the action on the tumor bed could preferably be carried out with transplantable tumors in animals. It must be placed on a sound statistical basis. Inbred strains of animals susceptible to transplantation of a spontaneous malignant tumor must be used so that essentially all transplants would take. Fortunately, Dr. Bittner had developed such a strain of mice and made it available for the study. The Department of Biostatistics supplied help for the analysis of the results. Thus it became possible to carry out a long time study which has yielded much information concerning the effects of irradiation of the tumor bed as well as on the tumor growth at different intervals after the transplantion.

Destruction of tumors by means of radiation is based on a differential effect. The cancer cells must be damaged to such an extent that they cannot recover while the surrounding tissues recover enough to function satisfactorily. Many attempts have been made to increase the relative effect on the cancer cells. It was hoped that certain types of ionizing radiation (e.g. specific wavelengths) would have such selective action but none has been found. Any substance which is selectively concentrated in cancer cells may contribute to radiation effects. Heavy metals such as lead have been tried without any apparent success. Cooperative research with the investigation of porphyrins is being undertaken. The possibility of synergistic effects between certain therapeutic agents (such as nitrogen mustard) and radiation must also be evaluated.

A variety of investigations have been performed with radioactive elements and isotopes. Nurnberger's thesis was based on effect of gamma-rays from radon on aqueous solutions. Wang used the first available amounts of Sodium^{24} and Chlorine^{38} to study the ionic diffu-

sion rates across biological membranes. A number of other investigations have been carried out which will not be detailed here. Cooperation with members of other departments has been rather extensive. The most consistent cooperation has been with the Neurosurgery Department in the use of different radioisotopes as a means of localizing brain tumors.

Personnel

The Radiation Therapy Section has expanded continuously since its inception and the personnel have been gradually increased. One part-time technician was the lone person assigned to the section when I came. The x-ray therapy was started with the help of a fellow in Radiology and a part-time nurse. Gradually more assistants were obtained but shortage of help was a chronic ailment as the activities increased. The most crying need was for physicists as the treatments are based upon physical investigations and measurements and new physical methods were being introduced in rapid succession. Few physicists are attracted to the medical field, and it is difficult to obtain adequate salaries.

A physicist was, however, soon added to the staff. The next addition was an instructor in radiation therapy. To keep adequate records and take care of the office work and correspondence without secretarial or stenographic help proved to be an insuperable task. It was, therefore, a great improvement when a secretary was added to the section. The expansion has gone on continuously except for a period during the war years. At the present time the force includes, besides the director, one associate professor of biophysics, two assistant professors of radiology, one part-time assistant professor, one Cancer Society fellow, seven radiology fellows, one technologist, five x-ray therapists, one part-time radium technician, one full-time secretary and one half-time clerk-typist. It also includes a group employed through research funds; one research associate, one half-time instructor in biophysics, two technologists, one animal attendant, five part-time students as laboratory assistants.

This brief historical sketch has been emphasizing the early development and many of the more recent activities and changes have not been detailed. The things which are most familiar to you, such as the clinical research, have been discussed to a small extent while a fuller description has been reserved for less well known activities.

After 30 years of efforts, it is time for me to turn over the section

of Radiation Therapy to younger men who may vitalize it with fresh minds and new ideas. I am happy that it will be in good hands and that a fine personnel is available. To them all, I wish to express my gratitude for their loyalty and for the good years we have had together.

The amount of success obtained in clinical as well as in research fields is due mainly to the fine cooperation we have enjoyed with all the departments of the medical school. For this I am truly grateful and wish to extend my appreciation and my thanks to everyone concerned.

Editorial

Until Fall

With this issue the BULLETIN suspends publication until next fall. It has been an interesting year, indeed. The new format of the BULLETIN has met with general approval, according to the communications, both written and verbal, that we have received. During the summer we plan to circularize our readers, inviting their comments and suggestions. Several new features have already been proposed for next year which will most likely be incorporated.

At this point we wish to acknowledge with real gratitude the efforts of the many people who contributed in various ways to the publication of the BULLETIN. We were privileged to be associated with a hard-working board of editors, each of whom played an essential role.

We are particularly indebted to the members of the editorial staff of LANCET PUBLICATIONS who were responsible for preparation of the abbreviated versions of the staff meeting reports throughout the year. In addition, the same group at the outset of this venture, gave many helpful suggestions concerning style, format, and other technical aspects of publication.

Thanks go, too, to our printers, the Flour City Press, who have been most cooperative in every way and whose work has been technically excellent despite the frequent tardiness of the copy furnished them.

Members of our own office force, Miss Gloria Norell in particular, have put in many hours preparing material for publication, and we are grateful for their uncomplaining, invaluable assistance.

This year's staff meeting papers, we believe, hit a new high in excellence. Our thanks go to the various authors for their splendid contributions and for their generally consistent compliance with the earlier deadlines required by the new format.

We cannot deny a certain sense of relief that this final issue of Volume 27 has been "put to bed." At the same time we will miss the undeniable pleasure of seeing each semi-monthly issue come out, and we will be looking forward to the resumption of publication next October.

In closing we wish to extend to our students, faculty members, members of the Foundation, and all friends of the Medical School our hope that the summer will prove to be enjoyable and relaxing.

Minnesota Medical Foundation

The Foundation Health Forums—An Appraisal

The Minnesota Medical Foundation participated in a new venture during the past year. Through a series of panel discussions that were open to the public, an attempt was made to perform a public service, and at the same time to focus the attention of the community at large upon the activities of the Foundation and upon the contributions of the University of Minnesota Medical School to medical progress. The undertaking was unique in several respects. In formulating the program, the advice and experience of those in the practice of medicine in the Twin Cities was obtained. This was accomplished through the cooperation of the Hennepin County and Ramsey County Medical Societies. These organizations were official cosponsors of the Forums. In addition, the Health Departments of Minneapolis and of St. Paul aided in the effort in an official capacity. In order to find out what the public was interested in, and also to obtain the required publicity for the Forums, the cooperation of the newspapers in the Twin Cities was sought out, and generous support came from this area. DR. R. S. YLVISAKER, *Vice President* of the Foundation, was General Chairman of the Committee in charge of the arrangements.

The first series of Health Forums, which were offered in January, February and March under the title of "You and Your Health," were jointly sponsored by the Minnesota Medical Foundation, the Hennepin and Ramsey County Medical Societies, the Minneapolis and St. Paul Departments of Health, the Minneapolis Star, and the St. Paul Pioneer Press. The first Forum on "Heart and High Blood Pressure" was held in St. Paul in the theater section of the St. Paul Auditorium on January 25, and on January 29 at the Lyceum Theater in Minneapolis. In St. Paul, two representatives of the Ramsey County Medical Society joined two members of the Faculty from the University of Minnesota Medical School in answering questions that had been submitted to the St. Paul newspapers by their readers. Similarly in Minneapolis, two members of the Hennepin County Medical Society participated with the same two University representatives in answering questions sent in to the Minneapolis Star.

Except for a change in the personnel of panel members, the same arrangements were made for the Forum on "Miracle Drugs" held in

St. Paul and in Minneapolis during February. The final single Forum on "Cancer" was held in the Mayo Memorial Auditorium at the University on March 22 with representatives from the Hennepin County and Ramsey County Medical Societies and from the Medical School participating.

In trying to evaluate the results of such an effort, there are probably two features of the program that are involved. First, what about the quality and scientific integrity of the subject matter presented for public consumption? Without any question, the material was presented in a dignified, accurate, and informative manner. Not only was the public apparently pleased, but several members of the medical profession expressed their appreciation at having attended and having received information new to them. All of the panel members are to be commended for their effort.

Second, how much public attention was aroused by the Forums? This aspect of the endeavor can best be expressed in terms of attendance. The first Forum in St. Paul saw approximately one hundred people showing up. This was exceedingly disappointing in view of the excellent panel discussion. The small crowd was ascribed to poor publicity, which was particularly necessary for a new venture. The second Forum that followed immediately in Minneapolis had a much better attendance, perhaps because of better publicity, and because the Forum was held on Sunday afternoon. With each succeeding Forum the attendance increased, but not above 500 or 600, although the newspapers of the Twin Cities gave commendable and adequate publicity. Altogether, it is estimated that the five panel discussions attracted between 2000 and 2500 persons. One who attended all the Forums remarked about the apparent high caliber of the audience. Many civic, business and professional leaders of the Twin Cities were in attendance.

But the Forums attracted more attention than is at first apparent. Each of the panel discussions was given accurate and rather complete coverage in the newspapers, and a much larger audience was reached through this medium.

The organization and effort necessary for such panel discussions might well raise the question of whether similar Forums should be planned for 1957. Does the public want to be educated through such a medium? If one were to judge the results by the actual attendance figures, the program does not appear to merit continuation. When it is considered how much over-all effort goes into educating the public

about medical progress and health, one wonders how the Foundation can hope to compete for additional attention. Furthermore, in a metropolitan area like the Twin Cities the attempt is made every day to capture the attention of the public with first-class amusements, sporting events, civic enterprises, and cultural programs, and this does not count the appeal of the radio and television at home!

Nevertheless, such a program as envisioned by the Foundation merits further study. The public is interested. The information given out is sound and worthy of communicating to the public. It is hoped that the Health Forums will continue. An enterprise that embraces the medical profession, the newspapers, the Health Departments, and an outstanding medical school is an unusual and healthy cooperative effort in itself, and further joint programs should be encouraged. If the Health Forums are continued, it is suggested that wider publicity be gievn to each of the programs. It is hoped that the individual members of the medical profession will take a more active role in sponsoring the program, rather than leaving it to their officers in the County Medical Societies. Perhaps at some time in the future, the medium of television on a state-wide basis might be used for panel discussions on problems of health.

The officers and members of the Minnesota Medical Foundation wish to express their deep appreciation for the time and effort which each of the panel members gave to this program. Likewise, profound thanks go to the newspapers in the Twin Cities for their aid; to the officers of the Hennepin and Ramsey County Medical Societies, and to the ladies' auxiliary of the two Societies; to DR. KARL LUNDEBERG of the Minneapolis Health Department, and to DR. R. B. J. SCHOCH of the St. Paul Bureau of Health.

Student Memberships

We are pleased to announce that 110 members of this year's graduating class have joined the Minnesota Medical Foundation. They will thus receive the BULLETIN during their internships. We hope that their interest in the Foundation will continue throughout their years of medical practice.

Medical School Activities

Faculty News

Two members of the staff of the Department of Surgery have recently left to accept positions in other teaching institutions. In April DR. EDWIN L. BRACKNEY, *Instructor,* joined the faculty of the Medical College of Georgia in Augusta as Assistant Professor of Surgery. On July 1, DR. GRAFTON A. SMITH, *Instructor,* will become Assistant Professor of Surgery at the University of Missouri School of Medicine at Columbia. Both Dr. Brackney and Dr. Smith were associated with our Department of Surgery for a number of years, initially as fellows and later as staff members. Although we regret losing them, we are happy that these challenging opportunities have been offered them. They carry with them our best wishes for success.

DR. and MRS. O. H. WANGENSTEEN have recently returned from Italy where Dr. Wangensteen addressed a Symposium on Arteriosclerosis which was held at San Giovanni Rotondo. During their stay in Italy, the Wangensteens were received by Pope Pius XII and entertained by the Aga Khan.

At the annual business meeting of the Minnesota Section of the Society for Experimental Biology and Medicine on May 23, the following officers for 1956-57 were elected: President, DR. H. C. LICHSTEIN, *Professor,* Department of Bacteriology and Immunology; Vice-President, DR. WARD S. FOWLER, *Associate Professor,* Section of Physiology; Mayo Foundation, Rochester; and Secretary, DR. RICHARD T. SMITH, *Assistant Professor,* Department of Pediatrics.

The annual E. Starr Judd Lecture was delivered on May 24 by DR. ROBERT M. ZOLLINGER, *Professor and Chairman,* Department of Surgery, Ohio State University College of Medicine, Columbus, Ohio, who delivered an outstanding address entitled "Clinical and Experimental Observations on the Pancreas."

Faculty Publications

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SCHULTZ, A. L., SANDHAUS, S., DEMOREST, H. L., and ZIEVE, L.: Clinical Value of the Plasma Butanol-Extractable (Thyroxine) I^{131} in the Diagnosis of Hyperthyroidism and Myxedema. J. Clin. Endoc. & Met., 14:1062, 1954.

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THOMAS, L., BRUNSON, J., and SMITH, RICHARD T.: Studies on the Generalized Shwartzman Reaction. VI. The Production of the Reaction by the Synergistic Action of Endotoxin with Three Synthetic Acidic Polymers (Sodium Polyanethol Sulfonate, Dextran Sulfate, and Sodium Polyvinyl Alcohol Sulfonate). J. Exp. Med., 102:249, 1955.

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WANNAMAKER, LEWIS W.: Control of Group A Streptococcal Infections and Their Sequelae. J. Lancet, 75:197, 1955.

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CUMULATIVE INDEX: 1951-1956

From October, 1951, until June, 1955, the name of this publication was "Bulletin of the University of Minnesota Hospitals and Minnesota Medical Foundation." In October, 1955, the name was changed to "UNIVERSITY OF MINNESOTA MEDICAL BULLETIN."

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WEEKLY CONFERENCES OF GENERAL INTEREST

Physicians Welcome

Monday,	9:00 to 10:50 A.M.	OBSTETRICS AND GYNECOLOGY Old Nursery, Station 57 University Hospitals
	12:30 to 1:30 P.M.	PHYSIOLOGY- PHYSIOLOGICAL CHEMISTRY 214 Millard Hall
	4:00 to 6:00 P.M.	ANESTHESIOLOGY Todd Amphitheater, University Hospitals
Tuesday,	12:30 to 1:20 P.M.	PATHOLOGY 104 Jackson Hall
Wednesday,	7:45 to 9:00 A.M.	PEDIATRICS McQuarrie Pediatric Library, 1450 Mayo Memorial
Friday,	8:00 to 10:00 A.M.	NEUROLOGY Station 50, University Hospitals
	9:00 to 10:00 A.M.	MEDICINE Todd Amphitheater, University Hospitals
	1:30 to 2:30 P.M.	DERMATOLOGY Eustis Amphitheater, University Hospitals
Saturday,	7:45 to 9:00 A.M.	ORTHOPEDICS Powell Hall Amphitheater
	9:15 to 11:30 A.M.	SURGERY Todd Amphitheater, University Hospitals

For detailed information concerning all conferences, seminars and ward rounds at University Hospitals, Ancker Hospital, Minneapolis General Hospital and the Minneapolis Veterans Administration Hospital, write to the Editor of the BULLETIN, 1342 Mayo Memorial, University of Minnesota, Minneapolis 14.