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There is no ideal method of urinary diversion. Nephrostomy, ureterostomy, and suprapubic cystostomy require catheters, the care of which is troublesome. Infection is inevitable and formation of calculi frequent. There is no consistently successful type of ureterosigmoid anastomosis. Hinman and Weyrauch, in 1936, described many varied techniques, and since then many more variants have been tried. Ureterosigmoidostomy requires that the ureters be normal or only slightly dilated; moreover, it has been complicated by stricture at site of the anastomosis, reflux of gas and feces up the ureter, pyelonephritis, calculi, hyperchloremic acidosis, and progressive renal failure.

In 1888, Tizzoni and Foggi anastomosed the dog's ileum to the vesical neck. Mauclaire, in 1895, also using the dog, performed ureteroproctostomy and diverting colostomy, thereby separating the fecal and urinary streams. Gersuny, in 1898, anastomosed the ureters to a blind rectal pouch and brought the colon out under the external anal sphincter. In 1917, Neuhof repaired defects of the bladder with fascial grafts; subsequently, bone formation was noted. Bisgard, in 1943, formed an artificial bladder from an isolated sigmoid in two stages. In 1950, Merricks and Gilchrist used the ileocecal segment as a substi-
tute bladder. Bricker,\textsuperscript{8} in 1950, described the isolated ileac segment and ileostomy.

Various tissues and materials, including metal tubes, skin, fascia, blood vessels, and Fallopian tubes have been used as substitutes for part or all of the ureter.\textsuperscript{9-11} Straus\textsuperscript{12} used pedunculated flaps of tissue from the abdominal wall, only to note bone formation.

During the past decade the use of intestinal segments (ileum and sigmoid) as substitutes for part or all of the ureter and bladder has been popularized. The anatomic proximity, the intactness of blood supply, and the normality of peristaltic activity of isolated segments of intestine make them convenient substitutes for parts of the urinary tract. Objections have been made to the use of the intestine because it entails: 1) mucus secretion, 2) absorption of acid urinary constituents which may lead to hyperchloremic acidosis, 3) difficulty in permanent sterilization of the bowel, and 4) difference in peristalsis with churning and low pressure.

An ideal substitute for parts of the urinary tract should have the following characteristics: 1) availability as a viable graft, 2) pliability, capacity for expansion and contraction, 3) impermeability to the urinary constituents, 4) capability of eventual sterilization, 5) absence of mucus secretion, 6) accessibility for cystoscopy and other diagnostic procedures, 7) ability to separate the urine from the fecal stream, 8) adequate capacity as a reservoir, 9) urinary continence, 10) freedom from external appliances or artificial orifices.

This is a preliminary report describing techniques, uses, and results of the transplantation of vesical mucosal grafts to segments of bowel stripped of mucosa alone, and of submucosa as well. This procedure was aimed at preventing the reabsorption of electrolytes from the urine and removing the troublesome mucus which fosters stone formation and infection.

**Technique**

Eighty-two dogs of both sexes, weighing from 30 to 80 pounds, were used. The bowel was cleansed before operation with Neomycin,\textsuperscript{®} sulfasuxidine, castor oil, and Fleet's enemas.\textsuperscript{®} Anesthesia was intravenous veterinary Nembutal.\textsuperscript{®} Segments of ileum 15 to 25 cm. long were isolated. Bowel anastomoses were made end to end, using four-O chromic catgut as a continuous Connell stitch, reinforced by a second outer layer of interrupted five-O silk. The isolated intestinal loop was opened on the antimesenteric border, and a rubber-shod clamp occluded the mesenteric vessels. The mucosa was removed by sharp and blunt
dissection; Peyer’s patches were scraped off with a knife. In other experiments mucosa and submucosa were removed, but this left a more rigid, less flexible intestinal segment than when mucosa alone was removed. The occluding clamp was removed, bleeding vessels were ligated with four-0 chromic catgut, and hot and then cold packs were applied for 15 to 20 minutes to the denuded surface for additional hemostasis.

Fig. 1. Ileum with mucosa removed
Vesical mucosa was obtained by: 1) distending the bladder and incising its wall down to the mucosa, which was then freed from the muscularis by sharp and blunt dissection; 2) after subtotal cystectomy, separating the mucosa of the removed portion by blunt and sharp dissection. (The latter is the more difficult method.)

Part or all of the ureter was replaced as follows: An appropriate length of ileum was isolated and slit; it was then trimmed to a width of one and one-half centimeters. The mucosa (or mucosa and submucosa) was removed. One or more pieces of vesical mucosa were then sutured to the denuded ileac surface with several interrupted sutures of four-0 chromic catgut. In most instances almost the entire raw surface of bowel was covered. The strip was made into a tube over polyethylene or rubber catheters with four-0 chromic catgut. With the same suture one end was anastomosed to the renal pelvis or upper ureter, and the other to the lower ureter or bladder. The splinting tube emerged either through the urethra or bladder and was firmly anchored with wire. The mesentery and ileac segment were stitched to the dorsal parietal peritoneum to prevent internal hernia.

In other experiments, isolated ileac segments were lined with vesical mucosa after their own mucosa was removed, both with and without submucosa. To prevent reduction in the capacity of this bowl, polyvinyl molds (each 10 to 15 cm. long and 1½ to 4 cm. in diameter) were left inlying from 7 to 14 days; these were then replaced by the inflated balloons of Foley catheters for another week. The uretero-ileac anastomosis was performed by the technique of Nesbit,13 7 to 30 days later. The left ureter was brought through the mesocolon across the midline. The ileostomy site was prepared by excision of ellipse of abdominal wall and the ileostomy sutured to peritoneum, fascia, and skin with four-0 chromic catgut. The loop was stitched to parietal peritoneum to prevent internal hernia. Later all this was done in one stage by splinting the ureters with ureteral catheters which emerged through the lumen of a polyvinyl mold (10 to 15 cm. long and 1½ to 4 cm. in diameter) within the bowel. Splints and mold were removed in 14 to 20 days.

Ileocystoplasty was accomplished in either of two ways: In the first method, a coronal incision was made through the vesical wall down to but not including the mucosa; the muscularis was removed leaving intact mucosa. Ileum denuded of mucosa or of mucosa and submucosa was then sutured over the vesical mucosa to the bladder. In the alternative technique, the dome of the bladder was partially resected, the defect being
covered with seromuscular segments of ileum, with or without its submucosa.

Fig. 2. Ileac pouch with mold

Following a subtrigonal or hemitrigonal cystectomy a repair was carried out by using ileum covered with transplanted vesical mucosa and by reimplanting one ureter into the ileac pouch.

Postoperatively the dogs received 1.5 million units of penicillin daily; vitamins, milk, and meat were given as soon as tolerated. Blood chemistries were determined monthly or bi-monthly.

**Experiment I:**

In eight dogs the mucosa was removed from an isolated segment of ascending colon and replaced with vesical mucosa. In eleven more the mucosa and submucosa were removed from a pouch of ascending colon, and vesical mucosa was substituted.

Removal of mucosa and submucosa, though easier than removal of mucosa alone, resulted in a stiffer, more rigid pouch of smaller capacity. Troublesome bleeding with retraction of the vessels into the mesentery on occasion produced necrosis of the bowel.

**Experiment II:**

In nine dogs vesical mucosa was used to line ileum denuded of mucosa or of mucosa and submucosa. To prevent a decrease
Removal of all the bladder except one-half the trigone repaired with non-reversed submucosal seromuscular ileum without vesical mucosal graft
in capacity of the loop, a mold was inserted for 7 to 14 days and was then replaced for several days by a catheter with a balloon inflated to 75 cc. These animals served as control subjects, so that at varying intervals vesical mucosa and ileac wall could be examined microscopically. The transplanted vesical mucosa was observed to have survived in all nine animals.

**Experiment III:**

In 17 dogs experiment II was repeated. Seven to 30 days later, depending upon the postoperative condition of the animal, uretero-ileac anastomoses were made. In two, bilateral hydrenephrosis was produced by stomal stricture and disappeared after revision. In three animals, unilateral hydrenephrosis was produced by stricture of uretero-ileac anastomosis; and after revision disappeared in two of them. No electrolyte imbalance was seen. The capacity of the pouch was observed to be larger when early transplantation was done; this finding led to experiment IV.

**Experiment IV:**

In eight dogs, the vesical mucosa was transplanted to a segment of prepared ileum, the ureters were anastomosed to ileum, and an ileostomy was performed all in one stage. Whereas the initial mortality and morbidity were high, they decreased with experience. The tendency for the pouch capacity to decrease was much less when the uretero-ileac anastomosis and vesical transplant were carried out in one stage.

**Experiment V:**

In nine dogs, the dome of the bladder was resected. In four, a patch of prepared ileum with transplanted vesical mucosa was substituted; and in the other five, the defect was repaired with a bare seromuscular patch of ileum. All animals later had normal cystograms and were able to empty their bladders. Vesical mucosa gradually grew out to cover the denuded ileum.

**Experiment VI:**

In each of seven dogs the bladder together with one half of the trigone was replaced with ileum denuded of mucosa, and a ureter was implanted into the ileac pouch. Within 25 days vesical mucosa covered the denuded ileum. A mold was not used to maintain bladder capacity. The animals voided 150 to 250 cc. at a time with no residual urine. Postoperative blood chemistries and excretory urograms were normal.

**Experiment VII:**

In each of seven dogs a part or all of one ureter was replaced
by tailored denuded ileum with transplanted vesical mucosa. These ureters exhibited active peristalsis, and no stasis or hydronephrosis was evident in the excretory urograms.

Fig. 4. Vesical mucosa covering submucosal seromuscular ileac patch in the bladder — 12 months postoperatively
Fig. 5. Right ureter partially replaced with nonreversed submucosal seromucosal ileal segment with transplanted vesical mucosa – 8 months postoperatively

Experiment VIII:
In one dog both ureters were replaced with the narrowed
ileum lined with vesical mucosa. The upper urinary tract was normal, as were the blood chemistries.

Experiment IX:

In each of five dogs one end of a tube of ileum with transplanted vesical mucosa was brought out as an ileostomy; the other end was anastomosed to the bladder, and the urethra was closed. The excretory urograms were normal, and the dogs were incontinent.

The high mortality described below was primarily due to the inexperience of the operator early in the experiments, the prolonged operating time, and also to the poor quality of postoperative management. Thirty-one of 82 dogs died from the following causes: anesthesia, 2; poor immediate postoperative care, 7; pneumonia, 9; intussusception, 5; abortion, 3; peritonitis, 2; volvulus, 2; and pyonephrosis, 1.

Discussion

The use of ileal segments has provided an excellent replacement for all or part of the ureter and bladder, but electrolyte imbalance and the secretion of mucus have been disadvantages in this procedure. Transplantation of vesical mucosa to the ileum after removal of the mucosa or of both mucosa and submucosa has offered an even better substitute for ureter and bladder, since mucus was not present and hyperchloremic acidosis did not occur. Studies on the absorption of electrolytes across the transplanted vesical mucosa are now being made.

Preparation of the ileum for acceptance of vesical mucosa required attention to minute details. Failure to remove all the mucosa or all of Peyer’s patches resulted in regeneration of ileal mucosa and sloughing of the graft. Tendency to contracture by the ileum stripped of mucosa and submucosa was a considerable problem; it was partially overcome by the use of molds or inflated balloons until the relined segment was put to work. When the ureters were transplanted to the ileal segment at time of the mucosal transplantation, the tendency to contracture diminished.

Replacement of ureters with similarly prepared ileum required prolonged ureteral catheter splinting to prevent stricture formation. Once the entire ileum was lined with vesical mucosa, stricture did not occur.

When part or all of the bladder and one-half of the trigone were replaced by ileum with or without vesical mucosa, peristaltic activity of the transplanted bowel was sufficient to prevent significant accumulation of residual urine. Mucus was not
a complicating factor. Following removal of the bladder and one-half of the trigone, tendency to contracture was present until the entire denuded surface of the ileum was covered by vesical mucosa; this took 15 to 25 days. The tendency for contraction of the patch was greatly diminished by the simultaneous transplantation of vesical mucosa to its denuded surface.

The hydronephrosis associated with use of an isolated ileac segment was due to stenosis of the external stoma or uretero-ileac anastomosis. The former could be prevented by daily dilatation. Hyperchloremic acidosis did not occur.

Among the investigators who have been concerned with bladder substitution methods, Harada and his associates have formed bladders by implanting vesical mucosa in the abdominal rectus muscle of the dog. Marshall and Spellman reported the use of vesical mucosa in the repair of hypospadias. Bohne and Richardson have emphasized the regenerative powers of the whole bladder.

The replacement of the entire bladder, as in cystectomy for carcinoma, has yet to be satisfactorily done. It is quite likely that transitional epithelium from the urethra and ureter will eventually be used to line a denuded ileac surface. The problem will be to reduce the prolonged operating time and to prevent decreased capacity by the use of appropriate molds.

Unfortunately, since the usual indication for cystectomy is cancer of the bladder, in many cases in which the ileum lined with vesical mucosa might be used to replace the bladder, no vesical mucosa will be available. For this reason, we have alternatively used split thickness skin grafts to line ileac segments; this procedure will be reported in a separate paper.

SUMMARY

A technique has been described for the replacement of intestinal mucosa with uro-epithelium. The use of segments of intestine so prepared as substitutes for part or all of ureter and bladder, and as conduits to the outside, has been described. Uro-epithelium was observed to have a remarkable proliferative capacity, which make it especially suitable for this purpose. One of the primary problems that remains with this procedure is the tendency toward contracture of ileum lined with transplanted vesical mucosa.

REFERENCES

University Hospitals in the State Welfare Structure*

Annie Laurie Baker, M.A.†

Minnesota has a national reputation for its excellent public welfare programs. Traditionally Minnesota's attitude toward people in need has always been liberal and is reflected in its excellent social agencies and facilities. The provisions for medical care are an important part of any plan designed to help people in need, and medical care programs to be effective must be supplemented by good public and private social agencies.

In the past decade major changes have occurred in the University Hospitals and in medical care plans for people in the communities these Hospitals serve. These changes need to be evaluated so that future planning can be sound and progressive.

The Hospitals staff has had the cooperation of the public welfare program in completing medical care, in protecting services given, and in aiding and supporting research. During the past half century, the medical school has depended upon community agencies to help provide patients for its clinical teaching. Moreover, the revised undergraduate curriculum will bring staff members into more immediate contact with many patients who are dependent for their living upon the agencies to be considered. A general knowledge of the public welfare services can aid in working out plans for medical care. Furthermore, a knowledge of the type of care available for the people of this state will provide a better basis for evaluating proposed state and national legislation.

This paper will explore the resources for medical care and treatment of Minnesota residents who cannot meet the total expense of illness. This is a broader category than that of indigent

*This report was given at the Staff Meeting of the University of Minnesota Hospitals on April 29, 1960.
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patients and includes people whose health insurance coverage puts them in the private patient class, but who are in all other respects indigent; it also includes patients with resources sufficient for private medical care who are given University Hospitals State and County papers because of special circumstances, such as a temporary lack of funds available for hospitalization.

The University Hospitals functions are: Teaching, Research, and Service. In providing medical services to patients it holds a magnificent record attested to by the ever-increasing numbers of people who come to it for care. Physicians and other professional people trained by its staff are working throughout the world. The research done within its walls has changed the course of medical history. The contribution made by its staff will affect generations of people all over the world. This paper, however, will be restricted to describing its contributions to the 87 counties of Minnesota, which according to the 1958 census had a total population of 3,370,000.

CHANGES IN UNIVERSITY HOSPITALS SINCE 1950

The University Hospitals is by law the primary resource on which all doctors and social agencies of the state draw in providing medical care. Therefore, a review of the changes that have occurred in the University Hospitals will be helpful.

1) The number and financial classification of patients of the University Hospitals have changed as follows during the last ten years:

<table>
<thead>
<tr>
<th></th>
<th>1950-51</th>
<th>1958-59</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Inpatients</td>
<td>10,831</td>
<td>16,322</td>
</tr>
<tr>
<td>Average Hospital Census</td>
<td>391</td>
<td>561</td>
</tr>
<tr>
<td>Financial Classification:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>County</td>
<td>4,415</td>
<td>4,255</td>
</tr>
<tr>
<td>Per Diem and Private</td>
<td>2,748</td>
<td>8,837</td>
</tr>
<tr>
<td>Outpatient Clinic Visits</td>
<td>100,656</td>
<td>131,293</td>
</tr>
<tr>
<td>Private North Clinic Visits</td>
<td>13,420</td>
<td>22,564</td>
</tr>
<tr>
<td>Total Expenditures</td>
<td>$3,107,142.69</td>
<td>$8,258,537.15</td>
</tr>
</tbody>
</table>

2) Since 1950, the following new departments have been added:

   Department of Physical Medicine & Rehabilitation
   Department of Anesthesiology
   North Clinic for Private Patients
   Inpatient Psychiatric Service for Children.

3) The Hospitals participation in the Blue Cross insurance
plan extended the areas of service to include an increased number of paying patients.

4) With the rise in rates because of increased operating costs, University Hospitals care, even on the shared basis, now costs as much as or more than the medical care offered by other local facilities.

5) The introduction and use of new drugs and methods of treatment have greatly benefited patients in some diagnostic groups (for example, tuberculosis, syphilis).

6) The improvement and extension of medical facilities in local communities have made it possible for more patients to return to their home localities.

CHANGES IN MINNESOTA'S MEDICAL CARE PROGRAMS SINCE 1950

The developments in the state affecting the medical care of people within the past ten years are spectacular and include the following:

1) The Hill-Burton Act, making funds available for the construction of medical facilities, has resulted in the erection of new hospitals—particularly in the less heavily populated rural areas.

2) Since the 1957 Legislature made funds available for mental health clinics, ten new clinics have been established. When this construction program is completed, psychiatric services will be available to people in all parts of the state.

3) The extension of public assistance grants to provide medical care for recipients made possible the treatment of a large group of the medically indigent on a private basis.

4) The creation of medical advisory boards to assist the county welfare agencies has added another resource to county medical care programs.

THE RELATIONSHIP BETWEEN MINNESOTA HEALTH PROGRAMS AND PHYSICIANS

The health programs in this state are medically supervised. The State Department of Welfare and other agencies employ medical specialists as consultants. Members of the University medical staff have worked in this capacity and on state medical advisory boards. The laws carefully spell out the physician's place in the Public Assistance and Child Welfare programs. On the county level, physicians and social agencies cooperate in making plans for patients. The physician determines the course of treatment and usually has considerable voice in the selection
of facilities; his choice, however, may be conditioned by circumstances or by county welfare board policy. Thus patients who live in rural Hennepin County and are unable to pay medical expenses must be referred to the University Hospitals, since there is no other facility to which they may go. Some county welfare boards require the physician to refer patients to the University Hospitals when care cannot be provided in the county; others permit the physician to select any facility he wishes.

The public welfare programs and agencies to be reviewed have a part in the referral of patients to the University Hospitals and other medical care facilities. The county social worker, the public health nurse, and vocational counselors in their work with people, do case finding and initiate medical examinations and treatment. They also encourage people to return to medical care, assist them to follow doctors' recommendations, and conscientiously follow up to assure that maximum benefits from medical care are obtained. They work closely with the family physicians and other agencies giving medical care.

STRUCTURES AND FUNCTIONS OF THE COUNTY WELFARE BOARDS

The law of 1921 governing the University Hospitals established a cooperative relationship between county officials and the Hospitals administration. The boards of county commissioners were given the responsibility for authorizing the financial expenses of patients sent for care.

Within the past ten years all but eight of the boards of county commissioners have delegated this function to the respective county welfare boards. From the Hospitals' viewpoint this has been a fortunate arrangement, for the county welfare agency is the local organization responsible for providing financial assistance and social services to people in need within the county.

Each of the 87 counties in the state has a county welfare board. The establishment of these boards was one of the requirements of the Social Security Act passed by Congress in 1937. In Minnesota each of these county welfare boards is composed of from three to five county commissioners, who are elected officials, plus two citizens (one of whom must be a woman) appointed by the Commissioner of the State Department of Welfare.

Broadly stated, the function of the boards is to provide financial assistance and social services to people in need. Specifically, their duties are as follows:

1) Appointment of a director and other necessary personnel.
2) Direction and administration of the public assistance program.
3) Supervision of child welfare services.
4) Supervision of patients discharged from the state mental hospitals.
5) Supervision of patients committed as feebleminded and epileptic to the guardianship of the Commissioner of Public Welfare.
6) Administration of General Relief (except in the township system counties).

PUBLIC ASSISTANCE PROGRAM

Illness is one of the most frequent causes of financial dependency, and is a common problem observed in the casework services of the county social worker. The public assistance programs have helped many people who were seriously ill. The largest number of Aid to Dependent Children’s grants are given because of the physical incapacity of the father; Aid to the Blind in most instances is given because of eye diseases; Aid to the Disabled on the basis of total physical incapacity. Services for the older age group are often directed at treating illness, while child welfare services are frequently concerned with corrective and preventive medical care. Thus a great share of the work of the county welfare agencies deals with illness, medical care, and rehabilitation.

The University Hospitals staff is familiar with county welfare board functions through services to patients via the public assistance programs. The medical report form for eligibility (form No. 32), which must be completed by the medical staff, is an essential requirement for eligibility. Many people who come to the outpatient clinics are actually subsisting on the financial aid from these programs, including:

1) Old Age Assistance—Financial help to people 65 years or older. The maximum maintenance grant is $71 per month.
2) Aid to Dependent Children—Financial assistance for children under 18 years of age who have been deprived of adequate support by death, incapacity, or desertion of one or both parents. The criterion of eligibility is financial need, and the amount of the grant is based on income, number of children, and budgetary requirements.
3) Aid to the Blind—Financial assistance for people with vision of 20/200 or less in the better eye after correction or equivalent limitation in visual fields. The amount of the grant is determined by the budgetary requirements.

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All three of these programs provide for the expenses of medical care. In some counties the recipients have free choice of physician and may go to the facility of the physician's choice. For example, in January, 1960, in Hennepin County, 532 recipients of public assistance were in private hospitals.

4) Aid to the Disabled — A grant of $70 per month per person for those who are totally incapacitated, to help provide for assistance by another person; no provisions for medical care are included.

In January, 1960, the recipients of public assistance in this state were distributed in the following categories:

**Recipients of Public Assistance — January, 1960**

<table>
<thead>
<tr>
<th>Category</th>
<th>Recipients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Age Assistance</td>
<td>113,933</td>
</tr>
<tr>
<td>Aid to Dependent Children (9,646 families)</td>
<td>46,794</td>
</tr>
<tr>
<td>Aid to the Disabled</td>
<td>2,315</td>
</tr>
<tr>
<td>Aid to the Blind</td>
<td>1,073</td>
</tr>
<tr>
<td>Direct Relief</td>
<td>9,667</td>
</tr>
</tbody>
</table>

Total: 173,782

Direct Relief provides temporary financial help for people who are without food, shelter, and other basic necessities of life. Medical care is not a part of the plan except in emergency situations. This aid, however, is an important part of any medical care plan, for health care without the basic necessities of life is ineffective.

The funds for relief come out of the general revenue fund of the county and are seldom adequate to meet the needs. Where the county welfare agencies have the control of relief funds, however, the additional resources essential to complete medical care plans are provided. These are nursing home care, physical therapy, special diets, foster homes, etc. In 20 of the 87 counties, relief funds are not administered by the county agency but by the township officials. Since the township is the smallest of all political units, it is frequently unable to meet the financial needs of its indigent residents.

**Child Welfare Services**

In addition to the public assistance programs, the county welfare agencies are by law responsible for providing protective services to children. The major services are:

1) Consulting with and advising parents when family break-up threatens or problems endanger children's normal development;
2) Assisting parents, children, and juvenile courts in cases of child dependency, neglect, or delinquency;

3) Supervising children under state guardianship or temporary custody;

4) Planning for the care and protection of unmarried mothers and their children;

5) Investigating petitions alleging mental deficiency or epilepsy for probate courts, and supervising and aiding retarded children and adults;

6) Overseeing adoptions and placements of children.

The child welfare program aims in every possible way to help children grow into competent self-sufficient adults. To this end specialized medical services are extremely important.

At the University Hospitals, the staff has most contact with the child welfare services provided for children who are wards of the state. These are children who have been abandoned, removed from the custody of their parents because of neglect, given into temporary custody during a rehabilitative or educational program, or children whose physical disability makes them unsuitable for adoption.

Into the Pediatrics clinic also come many mentally retarded children for whom institutional care is essential. In these instances the families are advised to contact the county welfare board of their home community before filing the petition for commitment. The Department of Child Psychiatry probably has the most direct contacts with the child welfare workers with whom plans for the Child Psychiatry patients are worked out.

The County Medical Advisory Boards

As we have observed, the local physician and the county welfare agency cooperate in making the medical care plans. The patient's doctor determines what is required in the way of additional treatment, further evaluation, or hospitalization. The welfare agencies assist him in making the plans to fulfill his recommendations within the policies established by the welfare board.

In addition to the local physician, each county welfare agency has a medical advisory board. These boards represent an outgrowth of recommendations made by the American Medical Association's Committee on Indigent Care. In establishing a set of Guides for Evaluating Indigent Medical Care plans, approved by the House of Delegates in 1953, the committee advocated continuous liaison activity of the local medical society and the welfare agency. In order to comply with this recommendation in Minnesota, the county medical societies have appointed medical
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advisory boards, each composed of from three to five physicians, to work with the welfare boards on medical problems. The purposes of the medical advisory boards, as reported by the State Medical Advisory Committee to the Department of Welfare, are as follows:

1) To recommend sound policies and procedures governing medical care of indigent persons.
2) To interpret the medical care program to physicians, hospitals, and other health professions.
3) To act as liaison between the local medical society and the welfare board.
4) To establish fee schedules.
5) To take cognizance of the rising costs of medical care.

Under this last function county medical advisory committees are requested to encourage physicians to:

a. Use the hospital and nursing home only when the need is clearly defined.
b. Shorten the hospital period as much as possible without jeopardy to the patient.
c. Avoid the use of expensive drugs when lower priced ones serve as well.
d. Make wise and economical use of ancillary services in keeping with good medical care.
e. Transfer patients from hospitals to nursing homes as soon as warranted.
f. Resist family pressures for hospital or nursing home care if the patient's home is adequate.
g. Encourage nursing care in patient's own home rather than care in a nursing home.

In practice some of the medical advisory boards have accepted a far wider range of services than these functions outlined by the State Medical Advisory Committee. Thus, for example, members often help work out medical plans for individual patients. They may decide in reviewing the findings in medical report form No. 32 that further medical care is indicated to rehabilitate the patient. They may also evaluate medical reports and assist in making plans for additional treatment. In some communities they provide professional direction for the total medical care programs.

PUBLIC HEALTH NURSING SERVICES

The Public Health Nurse in every community assists patients in their medical care. According to the Public Health Nurses'
Section of the American Nursing Association, "the public health nurses provide nursing care and treatment, health counseling, and organize families and community groups for health purposes. Their activities include work in the home, clinic office, school and health centers. In all phases of the work, emphasis is placed on the prevention of disease, the promotion of health and rehabilitation. To individual families they give or arrange for nursing care of the sick."

In this state eight Health Districts exclusive of the Twin Cities employ 118 public health nurses; another 176 public health nurses are employed in schools, 19 are employed by cities, and one public health nurse works in the Indian Services, making a total of 314 public health nurses outside of Hennepin and Ramsey Counties.

The University Hospitals staff is most familiar with public health nursing services through referrals made for nursing services to University Hospitals patients. In this function, the public health nurse makes a valuable contribution to the completion and protection of the medical care given by the medical staff. Moreover, the public health nurse, working with the families in her own county, encourages many people to obtain needed medical care; she also helps the family doctor in providing medical care and in arranging for patients to come to the University Hospitals for services not available in their own communities.

_The State Department of Vocational Rehabilitation_

The State Department of Vocational Rehabilitation comes under the supervision of the Board of Education. Its function is to offer training, counseling service, and placement to people who are vocationally handicapped because of physical disability. Referrals to this agency are made by doctors, social agencies, schools, and others. By law the division must evaluate for its services people who are receiving compensation for industrial accidents and those who have applied for disability benefits under the Social Security Disability Act.

Through its own funds this agency pays for medical services to remove or ameliorate vocationally handicapping conditions or to enhance employability. These funds for medical care are limited and are usually reserved for those who have no other resources. Last year this agency spent about eighty thousand dollars on medical care.

Vocational rehabilitation is relevant because of the case finding and preventive services the counselors perform. Some people would not require training or transfer to other jobs if their
physical disabilities were corrected; they are accordingly re­ferred to the proper agency for medical care. For others, med­ical care is initiated either at the expense of that agency or some other agency.

Counselors assigned to specific areas soon get to know well the physically handicapped people in their districts; with the assistance of the family physician they evaluate these handi­caps and help plan whatever medical treatment is indicated. The University Hospitals staff is naturally most familiar with this agency as a resource for referral of patients who require assistance or training for employment. The counselors also work with local physicians in having patients sent to the University Hos­pitals' outpatient clinics for diagnostic evaluation and rehabili­tation services.

COMMUNITY MENTAL HEALTH CLINICS

This latest development in the total medical care program of the state came into being in 1957, when the Legislature pro­vided for state grants-in-aid to match local funds for the sup­port of mental health facilities.

The original appropriation was only $100,000, but this grant was so well administered that the last session voted $650,000 for additional centers. The mental health clinics are established on a regional basis, with one clinic serving the people in the several participating counties. At present there are 12 commu­nity mental health centers outside of the Twin Cities and Du­luth. Each of these clinics is staffed by a psychiatrist, a psy­chologist, and a psychiatric social worker. The State Depart­ment of Welfare has been most successful in recruiting well-qualified personnel, and these new facilities make psychiatric services readily available for the first time to people in the rural areas.

Few of these clinics have been in operation long enough to permit any conclusions about their effect on the referral of pa­tients to the University Hospitals. Thus far, the clinic staffs have initiated the referral of patients to the University Hospitals, and patients treated here by the psychiatric staff are referred to the community clinics for continued treatment.

OTHER STATE AND FEDERAL INSTITUTIONS

In addition to the agencies and services already discussed, the following state and federal institutions and programs refer patients to the University Hospitals for care:

I. State Crippled Children's Services, which provide med­ical care at Gillette Hospital for crippled children.
II. State Mental Hospitals
   Rochester
   St. Peter
   Hastings
   Anoka
   Fergus Falls
   Willmar
   Moose Lake

III. Tuberculosis Sanatoria
   Minnesota State Sanatorium, Walker
   Glen Lake
   Sunny Rest
   Nopeming
   Mineral Springs
   Riverside

IV. State Institutions with Medical Facilities
   A. Penal Institutions
      State Penitentiary
      Women’s Prison
      St. Cloud Reformatory
      Home School for Girls
      Training School for Boys
   B. Schools for the Mentally Retarded and Epileptic
      Faribault
      Owatonna
      Brainerd
      Lake Owassi
      Duluth
      Shakopee

V. Federal Facilities on Indian Reservation Hospitals
   Red Lake
   Cass Lake

VI. Veterans Administration Facilities
   Minneapolis Hospital
   Outpatient Clinics, Fort Snelling
   Psychiatric Hospital, St. Cloud

MEDICAL CARE FOR THE INDIGENT

The University Hospitals was established by law as the medical facility for the indigent. Long before the establishment of the county welfare board system, it was providing medical care for the people of the state. It has served as the primary medical facility for community agencies. The local doctors in community
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agencies refer people to the University Hospitals for medical care. The University Hospitals staff, in turn, refers patients to community agencies for financial assistance and services, and to the local physician for continued medical care.

Despite all these resources available for medical care, certain groups of people are unable to obtain the medical services they need. Those who have the greatest difficulty are people without medical insurance whose incomes and assets put them in the category of private patients, but whose credit is so overextended they have nothing with which to meet emergencies. Thus people whose take-home pay is about seven hundred dollars a month may have payments amounting to four hundreds dollars a month. These are likely to be fairly young people with small children. Sometimes they are considered "medically indigent," and to meet the emergency, the more liberal and financially able county welfare boards may certify them for care at the University Hospitals. (The family may reimburse the county agency at a later date.)

As for grants to older people under the Social Security pension plan, these on the average are small - sufficient to meet current living costs but too low to take care of medical expenses. In Minnesota, people receiving Social Security benefits may be given Old Age Assistance to meet the costs of medical care, or State and County papers for University Hospitals care if they are eligible. However, the limitation on property and liquid assets imposed by the public assistance programs and the strict determination of financial eligibility required by some general relief agencies at times make these needy old people ineligible for any type of assistance. They are then forced to use their life savings and thus deplete their financial resources.

In counties operated on the township system of relief, people who are not totally incapacitated but need financial help to complete medical care encounter great difficulty. For example, a man of forty, with a family, was recently refused the money for a pair of eyeglasses which he needed to pass the driver's test essential to getting a job. A mother of five young children, who is totally deaf, was denied a hearing aid which would be helpful to her. It is sometimes impossible to get new braces for children who have outgrown those supplied when they left the hospitals. The inadequacies of the township system of relief are felt most keenly by sick people.

Another group, perhaps among the most indigent of the state, is the Indians. Because of the limited economic opportunities on the reservations and adjacent localities they are forced to go elsewhere to find jobs. Their lack of education, vocational train-
ing, and work skills puts them at a great disadvantage in the competitive labor market. Inadequate nutrition, poor housing, and the standard of living imposed by abject poverty make this group especially susceptible to illness. While medical care is available on the reservation, the chance of making a living is not. The residence requirements and the reluctance of some communities to pay for medical care for Indians prevent Indians from getting the care they need. The trend now is to purchase hospital care in community hospitals on a contract basis instead of building new facilities. This is a progressive step, but the amount of money provided by the Indian Service to pay for medical care outside the Indian Hospitals is insufficient. Moreover, the Indian Medical Care program is often defeated because no good welfare program exists to support it. Reservation hospitals can provide medical care, but the Indian patient who is discharged is frequently unable even to get sufficient food to maintain his nutritional level. Thus the whole tangled problem of providing adequate medical and ancillary services for Indians needs careful consideration.

We have cited some of the barriers which keep people from getting the medical care they need. At least two of them require direct legislative action: The first is inadequacy of the township system of relief just discussed, and the second is the inconsistency in residence requirements for various types of financial assistance; the laws relating to residence for poor relief purposes constitute a real barrier which keeps some people from obtaining medical care at the University Hospitals.

The rising cost of providing medical care for public assistance recipients, particularly for old age assistance recipients, is cause for uneasiness. Any legislature could establish limitations on the program which would seriously reduce the medical care for old people and others. Some of the county welfare agencies are experimenting with private health insurance plans, and within a short time the medical needs of these clients may be met by health insurance. This would permit counties to release for other purposes the funds now spent for care of the aged; it would also make it easier to get funds from the Legislature for other welfare programs.

One area not generally considered within the province of medical care programs is the employment of people with physical disabilities. Since the aim of medical care, however, is to restore the patient to his maximum physical capacity, employment becomes a necessary adjunct to the care given. The employment of people with disabilities poses great problems. Insurance coverage, company health benefits, etc., all make it
exceedingly difficult for people with physical limitations to get jobs. The medical profession has a real part in this area—first in realistically evaluating the patient’s abilities, and second in interpreting what work limitations these disabilities involve.

The question frequently asked by the county agencies of the medical staff—“Can this patient work?”—has several implications. It may be asked in an attempt to help the patient and his family qualify for funds under one of the public assistance programs. The county agency may temporarily advance the money needed to care for the family until the patient returns to work. Most often the question is asked to help the county worker plan for the patient’s rehabilitation in his home community.

CONCLUSIONS

A significant expansion of medical facilities throughout the state has occurred during the past decade. Perhaps we have not yet had sufficient time to evaluate how these increases in local facilities will affect the University Hospitals. Some facts, however, are clearly evident:

1) The number of University Hospitals patients has grown consistently during the past ten years. New patients have increased by 9%, and total patient visits by 37%. Furthermore, as shown in Fig. 1, the distance of the patient’s community from the Hospitals is far less important than has usually been thought. For example, Dakota County, which borders on Hennepin, sent about the same number of patients as did Ottertail County, much farther to the northwest. Of course, one third, or 5,178 patients, out of the total of 15,035, came from Hennepin County (Fig. 1).

2) Localities with many medical facilities, clinics, new hospitals, mental health clinics, nursing homes, etc., sent as many patients as those with few resources. The counties which include the cities of Duluth, Brainerd, St. Cloud, Rochester, Fergus Falls, Crookston, Winona, etc., all have good facilities, yet many patients are sent to the University Hospitals from these areas. Those sending the smallest number of patients had the fewest local medical resources.

3) More patients come to the University Hospitals from the northern counties than from those to the south, since the community agencies in the southern part of the state send patients to the Mayo Clinic.

The conclusion to be deduced from these facts is that the local physician uses the University Hospitals as a resource for county patients for the same reason as he uses it for his private patients. Referral to the University Hospitals is made at the physician’s choice.
Fig. 1. Number of patients sent to the University Hospitals by Counties  
July 1, 1958, to June 30, 1959  
Total number of patients: 15,035
Several principles should be borne in mind if the University Hospitals is to continue to serve patients whose care is paid for by community agencies:

1) Administrative controls should be developed to protect and enhance the relationship between the community agencies and the University Hospitals.

2) The entire staff should become aware of the communities' interest in patients sent to the Hospitals.

3) Since the local physician is the key person in referring patients to the University Hospitals, he must be kept informed about the course of treatment given to the patients he sends, as well as about current research within the Hospitals which would aid him in his practice.

4) The entire staff of the Hospitals needs to appreciate the county agencies' concern about the cost of care; no bills submitted are so carefully scrutinized or reviewed by so many departments as are the bills for county patients.

5) The rising costs of medical care, the increase in rates, and the complications of modern medical practice require continual education of community leaders. The community agencies need to know the University Hospitals facilities, its staff, and its program.

The University Hospitals by law has a responsibility to the indigent people of the state, who represent an important segment of its patient population. Therefore its success depends in part on the contribution it makes to this group of patients.

Welfare programs established to help people must be supplemented by good medical care, and medical care programs have to depend upon welfare agencies to complete medical treatment plans for some of its patients. The people of Minnesota take pride both in the University Hospitals' achievements and in the welfare programs of their state. The University Hospitals, as the oldest and strongest arch in the welfare structure of the state, through its medical services, leadership, and concern has contributed significantly to the welfare programs of Minnesota.
Effect of Hydrogen Ion Concentration and Carbon Dioxide Tension on Oxyhemoglobin Dissociation*

J. D. MacArthur, B.S.‡
and
E. B. Brown, Jr., Ph.D.§

Classically the factors influencing the oxyhemoglobin dissociation curve have been observed to include temperature, salt concentration, pH, and pCO₂. Of these, variations in pH and pCO₂ are more frequently encountered in the laboratory and the clinic. Unfortunately, some confusion has arisen in the literature during the past thirty years as to the relative effect of these two factors in changing the position of the dissociation curves.

Bohr,¹ in 1904, first noted a shift to the right of the dissociation curves with increasing pCO₂. Mathison² confirmed this finding in 1912, and observed the action of lactic, formic, acetic, hydrochloric, sulfuric, and carbonic acids on the rate of reduction of oxygenated blood in nitrogen. He concluded — although somewhat uncertainly — that the accelerating effect of these acids was due mainly to the change they produced in the hydrogen ion concentration, as determined by a para-nitrophenol indicator.

Barcroft and Murray³ in 1923 evaluated the effect of pH on the affinity of hemoglobin solutions for carbon monoxide. They noted that hydrogen ion concentration was altered by the addition of hydrochloric acid and CO₂, and that the effect of CO₂ on the combination of CO and hemoglobin was no greater than that caused by a similar change in pH produced by HCl; they inferred, therefore,

*This report was given at the Staff Meeting of the University of Minnesota Hospitals on April 22, 1960.
†Supported in part by the Minnesota Heart Association
‡Senior Medical Student, College of Medical Sciences, and U. S. Public Health Service Post-Sophomore Medical Research Fellow
§Professor, Department of Physiology
that carbonic acid had no specific effect on the affinity of hemoglobin for O₂.

In 1933 Margaria and Green⁴ investigated the dissociation curves in two solutions of equine hemoglobin in which pH, ionic strength, and hemoglobin concentration were held constant. The hemoglobin O₂ dissociation curve of a hemoglobin solution containing NaCl but free of CO₂ and bicarbonate was found to be markedly to the left of that for a second solution in which the hemoglobin was presumably all in the carbamino form as a result of high bicarbonate content and high pCO₂. The authors admitted the possibility of a specific ion effect of HCO₃⁻ as compared with Cl⁻ on the curves, but they concluded from the evidence that CO₂ combined directly with hemoglobin to form a carbamino compound which decreased the affinity of hemoglobin for O₂.

In this investigation we sought to determine the hemoglobin O₂ dissociation curves for dog blood at high hydrogen ion concentrations and high pCO₂, to evaluate the change in the position of these curves with alterations in pCO₂ and pH, and to separate the independent effects of pCO₂ and pH on the curves.

Methods

Venous blood was drawn from healthy mongrel dogs into heparinized syringes. The blood was thoroughly mixed, divided into equal parts, and stored for a variable period in ice water, as dictated by the experiment.

Tonometry

The oxyhemoglobin dissociation curves were determined by equilibrating blood against known gas mixtures at 37.5° C. Tonometry was carried out for 40 minutes in 500 cc. cylindrical tonometers with blood samples of 10-15 ml., and the gas phase was changed twice during the equilibration. Evaporation of water from the blood sample was minimized by saturating the gas mixtures with water vapor at 37.5° C. This source of error was evaluated by measuring the hemoglobin concentration in the blood sample before and after tonometry and was found to be insignificant. Changes in the oxygen combining capacity of the blood with time were minimized by allowing the blood to stand one hour before equilibration.⁵,⁶ Changes in hemoglobin concentration resulting from differential draining of cells and plasma were standardized by the use of a fixed two-minute draining period before the sample was withdrawn from the tonometer.⁷ The final oxygen and carbon dioxide tensions in the gas phase were calculated from the analysis of a gas sample drawn from
the tonometer at the end of equilibration and analyzed on the Scholander 0.5 cc. gas analyzer. 8

Blood samples were withdrawn anaerobically from the tonometer into lightly oiled syringes. After these samples were thoroughly mixed, pH was determined immediately at 37.5° C. by means of a glass electrode and bridge circuit designed in this laboratory for blood pH evaluation, 9 and the remainder was used for determining oxygen content by the manometric method of Van Slyke and Neill. 10 No enzyme inhibitors were added to the blood. When pH determination could not be made immediately after transferring the samples from tonometer to syringe, the blood was stored in ice water until the evaluation could be made — an interval which never exceeded one hour. A correction of +0.01 pH unit was made for each hour of delay. 11

Oxygen capacity was determined by equilibration with air of an aliquot of the same blood used to determine the curve in each case.

Determinations

In the first series of experiments, oxyhemoglobin dissociation curves were determined by equilibrating blood samples with O2 tensions (pO2) spanning the steep portion of the curve and CO2 tensions (pCO2) of 40, 210, 340, and 440 mm. Hg. In these experiments blood pH varied as a function of pCO2.

In the second experiment, CO2 tension was held constant at 41 mm. Hg. The pH of the blood used for the experimental curve was reduced to 6.60 by adding 1.0 N HCl. An equal volume of 1.0 N NaCl was added to the blood for the control curve to equalize the salt effect, 12 13 and this curve was determined at the resulting pH, 7.27. In the final series of experiments, the control curve was again established at a pCO2 of about 40 mm. Hg and resulting pH 7.18 to 7.28. The experimental curve was determined at a pCO2 of approximately 200 mm. Hg on blood to which 1.0 N NaOH was added to increase the pH from 6.80 to a value approaching that of the control curve. Again an equal volume of 1.0 N NaCl was added to the blood used in establishing the control curve. The HCl and NaOH were added slowly with vigorous stirring of the blood to prevent denaturation of the blood proteins.

Calculations

The amount of physically dissolved O2 was calculated from the experimentally determined O2 tensions using a solubility coefficient for O2 in blood of 0.23 cc/cc atmosphere pressure. 14 The O2 combined with hemoglobin was obtained by subtraction.
The percent saturation values were calculated as follows:

\[
\text{Content (in volumes percent) - dissolved O}_2 \div \text{Capacity (in volumes percent) - dissolved O}_2 \times 100 = \text{percent O}_2 \text{ saturation.}
\]

The slope of the linear portion of the dissociation curves was calculated by division of the change in percent O\textsubscript{2} saturation, from 35 to 65 per cent, by the change in the logarithm of the corresponding values for pO\textsubscript{2} and reported in units of

\[
\frac{\Delta \% \text{ saturation}}{\Delta \text{log} \text{ pO}_2}
\]

Values for pO\textsubscript{2} were obtained by interpolation from the curves.

The shift to the right in the position of the curves with increasing hydrogen ion concentration was defined by the change in the interpolated value of the log pO\textsubscript{2} at half saturation divided by the decrement of serum pH, and reported in units of

\[
\frac{\Delta \text{log} \text{ pO}_2}{\Delta \text{pH} \text{ serum}}
\]

RESULTS AND DISCUSSION

Results of the first series of experiments are presented in Fig. 1. The mean slope of these curves, in which pH decreased

![Graph showing oxygen dissociation curves of dog blood at an equilibration temperature of 37.5°C.](image)
with increasing pCO₂, was 137 (range 135-139) units of \( \Delta \% \text{ saturation} \).\( \Delta \log \text{pO}_2 \)

A comparison with slopes for human blood, calculated from earlier data in the literature by Gullbring and Strom,¹⁵ is presented in Table 1, along with a value calculated from the work of Dill and co-workers¹⁶ on dog blood. This evidence demonstrated a constancy in the inclination of the flat portion of the curves between 35 and 65 per cent saturation when plotted against \( \Delta \log \text{pO}_2 \) independent of pH.

### Table 1

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Range of Percent Saturation</th>
<th>Slope: ( \Delta % \text{ Saturation} ) ( \Delta \log \text{pO}_2 )</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man</td>
<td>2 35–65</td>
<td>143</td>
<td>Gullbring and Strom¹⁵</td>
</tr>
<tr>
<td>Man</td>
<td>8 40–70</td>
<td>145</td>
<td>Keys and Snell</td>
</tr>
<tr>
<td>Man</td>
<td>? 40–70</td>
<td>139</td>
<td>Dill et al.</td>
</tr>
<tr>
<td>Man</td>
<td>? 40–60</td>
<td>133</td>
<td></td>
</tr>
<tr>
<td>Dog</td>
<td>2 40–60</td>
<td>149</td>
<td>Dill¹⁵</td>
</tr>
<tr>
<td>Dog</td>
<td>4 35–75</td>
<td>137</td>
<td>Present investigation</td>
</tr>
</tbody>
</table>

*Modified from Gullbring and Strom¹⁵ as determined in fresh heparinized blood and calculated from earlier data in the literature.

Displacement to the right of the curves with increasing hydrogen ion concentration, in units of \( \Delta \log \text{pO}_2 \) at 50% saturation, \( \Delta \text{pH serum} \) varied from -0.32 to -0.60; the tendency of the lower values to prevail at low pH has been observed by other investigators.¹⁵ If shifts to pH below 6.65 were eliminated, the range was -0.53 to -0.60 with an average of -0.57. Values for this shift calculated from the literature range from -0.08 to -0.9.

Data from the second experiment, presented in Fig. 2, show that increasing hydrogen ion concentration in the presence of constant pCO₂ displaced the curve (-0.32 units) to the right.

In the final series of experiments, pH was held nearly constant at two widely differing values of pCO₂. As can be seen from Figs. 3 and 4, these points correspond closely to a single
Fig. 2. Oxygen dissociation curves of dog blood at 37.5° C. under conditions of constant \( pC_0^2 \) and two different hydrogen ion concentrations

curve, and high \( CO_2 \) tensions failed to produce a detectable decrease in hemoglobin \( O_2 \) saturation. The curve on the right in these figures resulted from experiments at the same high \( pC_0^2 \) in which \( pH \) was allowed to change, and it is presented for comparison.

The data would be more convincing if the lower portion of the curves at high \( pC_0^2 \) had been evaluated, but the gas mixtures were chosen to determine the linear portion of curves at low \( pH \) and gave higher saturations when used at the high \( pH \).

This investigation of hemoglobin \( O_2 \) dissociation was confined to dog blood, but, in view of the similarity of dog, horse, and human hemoglobin reported in the literature, it is reasonable to assume that the results are applicable to blood of other species. These data support the conclusion that \( CO_2 \) and the associated carbamino compounds have no effect on the oxyhemoglobin dissociation curves apart from the influence of \( pC_0^2 \) in changing \( pH \). This confirms the earlier investigations of Barcroft.\(^3\)

Since the studies of Margaria and Green,\(^4\) oxyhemoglobin dissociation curves have commonly been reported in terms of the \( pC_0^2 \) at which they were determined. If the findings of the present investigation are correct, the positions of these curves
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should be discussed in terms of pH rather than pCO₂, since the relationship between these two is a function of a third variable—the plasma bicarbonate concentration. Values for per cent saturation would also be more informative if recorded at the associated pH and temperature, for if these two variables and either pO₂ or per cent saturation are known, they can be interconverted from factors outlined by Severinghaus.¹⁸

Fig. 3
Oxygen dissociation curves of dog blood at 37.5° C. and constant pH at two different CO₂ tensions

In addition, the concept that O₂ unloading in the tissues is assisted by a shift to the right of the dissociation curve with increasing pCO₂ should be reevaluated. Although the pCO₂ may change from a normal arterial value of 40 mm. Hg to higher venous tensions because of the isohydric transport of CO₂, arterial-venous pH differences are ordinarily very small.

SUMMARY

1. Hemoglobin O₂ dissociation curves were determined for dog blood at 37.5° C. and pCO₂ ranging from 40 to 440 mm. Hg. The slope and displacement of the curves with decreasing pH were calculated and compared to values from the literature.

2. Dissociation curves at 37.5° C. were determined on dog blood at constant pH and CO₂ tensions of 40 and 200 mm. Hg. Under these conditions of widely varying pCO₂ and fixed hydrogen ion concentration, the hemoglobin O₂ saturation was not
changed. From these findings it was concluded: 1) that CO₂ alone had no effect on the position of the curves, and 2) that the primary factor influencing the position of these curves was the hydrogen ion concentration. The implications of these conclusions were discussed.

REFERENCES


DR. CARLOS MARTINEZ NAMED CANCER RESEARCH PROFESSOR

The American Cancer Society has established a Cancer Research Professorship at the University of Minnesota, and Dr. Carlos Martinez, Professor of Physiology in the Medical School, has been appointed to the post. The position is endowed by a $100,000 trust fund, enabling the recipient to pursue a lifetime career in cancer research at his own direction and pace.

Dr. Martinez, a 46-year-old native of Argentina, is already well known for studies in cancer endocrinology and immunology, and has written 87 papers in these fields. He earned his Doctor of Medicine and Doctor of Philosophy degrees from the University of Cordoba, and joined the University medical school staff in 1951 as an Assistant Professor of Cancer Biology. With yearly support from the Minnesota Division of American Cancer Society, Dr. Martinez' research has been concerned with the hormonal factors in cancer from a genetic and immunological point of view. He is seeking understanding of hormonal factors responsible for development and growth of tumors, and also of the basic immunological mechanism underlying resistance to, or enhancement of, tumor growth.

Dr. Martinez is married and has four children. The American Cancer Society will finance his post—the first established at the University of Minnesota—with income earned from the Trust Fund, and supplemental funds raised each year. The University will also contribute to the support of the position, which was announced April 25, 1960.

Similar lifetime professorships with long term freedom in development of research have been founded by the American Cancer Society at six other research and teaching institutions.
They parallel the Career Investigatorships pioneered by the American Heart Association. Two Minnesotans, Dr. Victor Lorber, Professor of Physiology, and Dr. Lewis W. Wannamaker, Professor of Pediatrics, currently hold American Heart Association lifetime research appointments for heart disease research.

**DR. WILLIAM FLEESON NAMED ASSISTANT DEAN**

Dr. William Fleeson has been named an Assistant Dean of the College of Medical Sciences, succeeding Dr. Richard Magraw.

Dr. Magraw has assumed full time direction of the Medical School's new Comprehensive Clinic program. Dr. Fleeson, an Assistant Professor of Psychiatry and Physical Medicine, will spend approximately one-half of his time in the administration of the Medical School, with responsibility mainly for the present Freshman and Junior Classes.

**PEDIATRICS RESEARCH LABORATORY BEING BUILT**

A new pediatrics research laboratory is being built in heretofore undeveloped space on the 15th floor of the Mayo Memorial Building, home of the University of Minnesota's Medical School.

The $82,850 remodeling project was made possible by a $41,425 grant from the National Institutes of Health, which matched $20,000 contributed by the Sister Elizabeth Kenny Foundation, and various non-appropriated research grant funds available to the pediatrics department.

The new research area will be windowless and artificially lighted, and ventilated. A stairway from the 14th floor will provide access.

The Minnesota project was among 30 Health Research Facilities grants approved recently for federal support by the Surgeon General, U.S. Public Health Service. They totaled $2,999,415 to 30 institutions in 18 states. The Health Research Facilities program, established in 1956, and recently extended through 1962, made available $30,000,000 annually to award funds on a matching basis to public and private nonprofit hospitals, medical and dental schools, schools of public health, and other research institutions, for building and equipping health research facilities.
The Minnesota Medical Foundation has charted a future course in its support of the Medical School at the University of Minnesota. Meeting April 20, the Board of Trustees of the Foundation adopted a $62,500 budget for the 1961 fiscal year which would enact the following areas of support:

- Up to 40 scholarships for Medical Students.
- Expansion of the MEDICAL BULLETIN with revised format.
- Issuing of the Foundation's first Distinguished Service Professorship Award to an outstanding faculty member.
- Offering of research fellowships ($900.00 each) to medical students during periods of vacation and elective medical education.
- Establishing a basic research fund from which young investigators can receive research grants for fundamental studies.

This program was fashioned from recommendations growing out of the Lazarow Report, a 1958 study of the needs of the Medical School made by a faculty committee headed by Dr. Arnold Lazarow, Professor and Head of the Department of Anatomy. He is Vice President of the Foundation.

In addition, the Trustees approved an $18,500 operating budget for the coming year. The Foundation now has two full time employees, and is housed in offices connecting with the Medical School on the 13th floor of the Mayo Memorial Building on the University of Minnesota Campus.

Funds to finance next year's program will be sought by a special Fund Raising Committee organized under the leadership of Alan W. Giles, Minneapolis life insurance executive. Enactment of the various parts of the program, and the development of each, will depend on the results of fund raising work being carried on by the Committee during the Spring and Summer months.

Crystallization of its support program represents a milestone in Foundation annals. Previous to July 1959, the Foundation operated under part time supervision with fund raising and projects being activated only on special occasions.
GERSTENKORN WINS $4,000 M.S.M.A. AWARD

George Bruce Gerstenkorn, Medical School freshman from Belgrade, Minn., has been named winner of the $4,000 Rural Medical Scholarship presented annually by the Minnesota State Medical Association.

Gerstenkorn will receive $1,000 for school expenses each year for four years. In return, he promises to practice medicine for a period of at least five years after graduation in a Minnesota community in need of a doctor.

Gerstenkorn, 22-year old graduate of St. Olaf College, is also holder of a Minnesota Medical Foundation Scholarship. He is married, and becomes the eighth winner of the MSMA scholarship which is aimed at encouraging young doctors to practice in rural areas of Minnesota. In addition, said Dr. F. J. Elias, Duluth, chairman of the selection committee, the scholarship is designed to assist a worthy and outstanding student to meet the cost of medical education.

Three previous winners of the rural medical scholarship are now in practice. They are Dr. Richard Engwall (Med. '56), Ivanhoe, Minn.; Dr. Leland Christenson (Med. '57), Maple Plain, Minn.; and Dr. Myron Doebler (Med. '58), Ellendale, Minn. Dr. Carl E. Christenson (Med. '59), is now completing an internship at Bethesda Hospital, St. Paul, and will begin practice in Clinton, Minn., after July 1, 1960.

Scholarship winners still in training at the University of Minnesota Medical School in addition to Gerstenkorn are Edward S. Peterka, Aurora, Minn.; Vincent R. Hunt, Anoka, Minn.; and LeRoy Mueller, Belle Plaine, Minn.

CLASS OFFICERS NAMED

Clayton A. Johnson of Chisholm, Minn., has been elected President of the Medical School's Sophomore Class, effective for the coming academic year. Dick Siebert and John Wheeler, both of Minneapolis, were elected 1960-61 sophomore Class Representatives.
RADIATION THERAPY

Dr. Donn Mosser, Director of the Division, was main speaker when the 1960 fund appeal of the Hennepin County Cancer Society was launched in Minneapolis, April 7, 1960.

NEUROLOGY

Dr. Maynard Cohen, University Hospitals’ research neurologist, was appointed chairman of the Medical Advisory Committee of the Hennepin (Minneapolis) County chapter, National Multiple Sclerosis Society.

PHYSIOLOGICAL CHEMISTRY

Dr. Cyrus P. Barnum, Professor, spoke on “Hypotheses and Law” April 21 at the annual banquet and awards program held for University of Minnesota medical technology students.

ORTHOPEDIC SURGERY

Dr. Ignacio V. Ponseti, of the State University of Iowa Hospitals, was a recent guest of Dr. John Moe, Director of the Division, and spoke to residents and staff on “Developments in Research on the Etiology of Idiopathic Scoliosis.”

CANCER BIOLOGY

Dr. Herbert M. Hirsch, Associate Professor, was recently elected a Fellow of the American Academy of Microbiology. He also participated in the American Cancer Society’s Second Annual Science Writers Seminar in Louisville, Ky., during March, as an invited panel member on “Immunology.”

CLINICAL PSYCHOLOGY

Dr. Starke R. Hathaway, Director of the Division, has been appointed a member of the Mental Health Research Section, U.S. Public Health Service.

Dr. William Schofield, Professor, has been reappointed to the Committee on Education and Research of the American Association of Medical Colleges.

Dr. John O. Kangas, Instructor, is resigning, effective June 30, 1960, to become an Assistant Professor in the University of Oregon Medical School’s Division of Medical Psychology, Portland, Ore.
ALUMNI DEATHS

Dr. Andrew A. Kjelland (Med. '10) of Hatton, N. D., died January 18, 1960. He was 79 years old, on the staff of the Northwood (N. D.) Deaconess Hospital, and was a past president of the Traill-Steele District Medical Society.

Dr. Louis A. Mitchell (Med. '15) of Newark, Ohio, died January 17, 1960 at the age of 71 years. He was a Fellow of the American College of Physicians, a Diplomate by the American Board of Internal Medicine, and was on the staff of the Newark City Hospital. He was a veteran of World War I.

Dr. Norman E. Fidelman (Med. '47) died April 22, 1960 of a heart attack at age 35. He had been in the general practice of medicine in Foley, Minn. for the past 12 years. A member of local, state, and American Medical Associations, Dr. Fidelman was current president of the Central Minnesota Chapter of the American Academy of General Practice. He was a staff member of the St. Cloud, Minn. Hospital, and had served on occupation duty in Europe as a Captain in the U.S. Army Medical Corps. He is survived by his wife, Marian, three sons, and one daughter.

Dr. Robert K. Dixon (Med. '23) died Feb. 19, 1960 while in New Orleans, La. He was 61 years old, and made his home in Detroit, Mich., where he was associated with several hospitals. He was a fellow of the American College of Physicians, veteran of World War II, and for many years was associated with the Mayo Clinic, Rochester, Minn.

Memorial Gifts

Recent memorial contributions to the Minnesota Medical Foundation have been received in memory of:

Mr. Harry H. Halper
St. Paul, Minn.

Memorial gifts are a practical means of honoring the memory of a friend or loved one while providing needed assistance for the University of Minnesota Medical School. Dignified acknowledgments are made by the Foundation to both the donor and to the family of the deceased.
Alumni Notes

♦ 1921

Herman J. Moersch retired April 1, 1960 from the Mayo Clinic, Rochester, after 34 years on the staff. He was a senior consultant in medicine. Dr. Moersch will soon assume the post of Director of Education and Research for the American College of Chest Physicians. He is a past president of the College and of the Mayo Clinic staff.

♦ 1924

Arnold O. Swenson was among several Duluth physicians attending the American College of Obstetrics and Gynecology meetings in Cincinnati April 2-6, 1960.

C. F. Wohlrabe was appointed Health Officer for North Mankato (Minn.) by the City Council in that community.

♦ 1925

Thomas Moe was recently named to the Moose Lake (Minn.) Board of Health and named Chairman of the group. Dr. Martin S. Munson (Med. '47) was also appointed to the Board.

♦ 1926

R. S. Ylvisaker attended the meetings of the American Gastroscopic Society March 30-31 in New Orleans, La.

♦ 1928

Horace G. Scott, Minneapolis surgeon, was Chairman of the Host Committee when the American College of Surgeons held a sectional meeting in Minneapolis, April 11-13, 1960.

♦ 1930

U. Schuyler Anderson, Minneapolis surgeon, has moved into new offices at 753 Medical Arts Building, and consolidated his medical practice with that of Dr. Herbert W. Peterson.

Cyril Tifft, St. Paul, is 1960 President of the Minnesota Academy of General Practice.

♦ 1931

Stuart Lane Arey was elected Chief of Staff at Abbott (Minneapolis) Hospital. (The March 15 Medical Bulletin erroneously reported it was another hospital.)

♦ 1933

Alton C. Olson, President of the Board of Directors at Doctors' Memorial Hospital, Minneapolis, recently announced the hospital's name has been reverted officially to Eitel Hospital.
Founded in 1812, the hospital was originally named in memory of the late Dr. George G. Eitel (Med. '23). In 1954 the name Doctors' Memorial was adopted, but “the community continues to refer to the institution as Eitel Hospital so we are returning to the original name,” said Dr. Olson. Expansion plans are to be announced this Spring, he said.

♦ 1935

Mancel T. Mitchell was elected Chief of Staff at St. Barnabas (Minneapolis) Hospital. He has been on the staff since 1947. Dr. Charles R. Peluso (Med. '48) was elected Vice Chief of Staff, and Dr. Donald G. Bohn (Med. '45) was re-elected Secretary-Treasurer.

♦ 1937

Edmund B. Flink of Minneapolis is serving as 1960 President of the Minneapolis Society of Internal Medicine.

Kenneth L. Nelson is engaged in student health work at Texas A. and M. College, College Station, Texas.

♦ 1939

Robert A. Murray and Mrs. Murray of Hibbing, Minn., recently returned from a winter vacation trip through California, Texas, and Arizona.

♦ 1941

Hugh D. Patterson of Slayton, Minn. was elected President of the Southwest Medical Society. Also recently installed were Dr. R. K. Minge (Med. '39), Worthington, Vice President; and Dr. O. M. Heiberg (Med. '35), Worthington, Secretary. Dr. B. N. Karleen (Med. '39), Jackson, was named President-Elect.

♦ 1945

Maj. Cloid D. Green of the U. S. Air Force is now on duty at the Aerospace Medical Center, Brooks Air Force Base, Texas. He is engaged in research on the physiological aspects of space flight.

♦ 1946

Harold A. Wente of Rochester was recently elected President of the Olmsted Medical Group, succeeding Dr. J. E. Verby (Med. '47). Dr. W. R. Weyhrauch (Med. '51) was named Vice President.

♦ 1947

William J. Muesing is serving as 1960 president of the staff at both Union Hospital and Loretto Hospital in New Ulm.
Minn. Dr. Frank J. Carthey (Med. '52) is Vice President at Loretto, and Dr. C. A. Saffert (Med. '26) is Secretary at Union.

Maj. Paul Teschan, U. S. Army, is on duty at the Brooke Army Medical Center, Ft. Sam Houston, Texas, where he is in charge of the Renal Section of the Surgical Research Unit.

John M. Wolff, Duluth physician, has won a $500.00 research award from the Minnesota Chapter of the Arthritis and Rheumatism Foundation. His study will consist of analysis of synovial fluid in patients with rheumatoid arthritis. the Hutchinson Medical Center.

♦ 1949

Gilbert H. Friedell is an Associate Professor of Pathology at the Massachusetts Memorial Hospital in Boston, and the Harvard Medical School. He was recently home for a visit with his father, Dr. Aaron Friedell (Med. '22) and mother in Minneapolis.

♦ 1952

Carl O. Bretzke was named the "Outstanding Young Man of 1959" by the Hutchinson, Minn. Junior Chamber of Commerce and given the Jaycees' Distinguished Service Award. He is Secretary of the McLeod County Medical Society and a founder of

♦ 1953

James C. Melby is now an Assistant Professor of Medicine in the University of Arkansas School of Medicine, Little Rock, Ark. He recently returned to the University of Minnesota to be a guest speaker at a Continuation Medical Education course on Endocrinology.

♦ 1958

Lt. Robert S. Swenson, U. S. Navy Medical Corps, has been transferred from fleet duty to the U. S. Naval Station, Long Beach, Calif.
Progress Report

Class of 1959 Scholarship Fund

RECENT CONTRIBUTORS

Jack O. Hubbard
Arthur T. Lindeland
Charles B. McCreary
Duane L. Orn
Barbara M. Puumala
Ricard Puumala
Robert L. Sadoff
George Skaff
J. F. Tuohy

Total Contributions to Date ................. $78.00
Number of Contributors ...................... 58
Number of Class Members ..................... 113
Percent of Participation .................... 51%
Current Year's Goal ........................ $125.00
*Objective by 1963 ......................... $500.00

*To underwrite a “Class of 1959 Scholarship” for a meritorious medical student in September 1963.
Coming Events

University of Minnesota Medical School

Courses in Continuation Medical Education During 1960

May 16-18 . . . . Psychiatry for General Physicians

May 23-27 . . . . Proctology for General Physicians


Courses are held at the Center for Continuation Study or at the Mayo Memorial Auditorium on the campus of the University of Minnesota. Usual tuition fees are $10 for a one-day course, $40 for a three-day course, and $65 for a one-week course. These are subject to change under certain circumstances.

Register early. For further information write to:

DIRECTOR
DEPT. OF CONTINUATION MEDICAL EDUCATION
1342 Mayo Memorial — University of Minnesota
Minneapolis 14, Minnesota
A Word About Memorial Gifts

Many people have adopted the appropriate custom of sending memorial gifts to worthy organizations in time of bereavement or other occasion. Such funds have lent significant strength to the fight against the major diseases known to Americans.

The Minnesota Medical Foundation welcomes your memorial gifts when an appropriate occasion arises. Memorial gifts serve the living and pay thoughtful tribute to the memory of a friend, associate, or relative. The Foundation will acknowledge gifts with suitable cards mailed promptly to both the donor and the family of the deceased. The gift will help finance the Foundation’s program of support for the Medical School of the University of Minnesota.

Special memorial funds may be created within the Foundation on request to serve as a permanent repository for continuing contributions.

When making memorial gifts to the Foundation, include the names and addresses of the deceased, next of kin, and the donor.

MINNESOTA MEDICAL FOUNDATION
1342 Mayo Memorial
University of Minnesota
Minneapolis 14, Minnesota