ORGANIZATION AND OPERATION OF A BLOOD BANK AND INTRAVENOUS SERVICE

RALPH M. TOVELL, M.D., M.SC. (A.M.), AND THOMAS WALKER, M.D.†

Hartford, Connecticut

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Experience gained since the establishment of the first blood bank at the Cook County Hospital (1) has shown that the storage of whole blood is feasible and, in many instances, life saving. Ready availability of this biologic therapeutic agent is essential in the modern hospital. The larger hospitals throughout the country have established blood banks, and many smaller hospitals are considering and planning establishment of similar facilities. Experiences of World War II demonstrated the feasibility of providing blood for the armed forces. Whole blood is now considered so necessary in the reduction of mortality and morbidity that no community is too small to require the services of a smoothly functioning blood bank. It, therefore, becomes the duty of each community to assure an adequate supply of blood for its members in need of such therapy. It is the responsibility of the medical profession to provide facilities to meet the need. It is in the assumption of this responsibility that anesthesiologists in cooperation with pathologists and civic-minded laymen may lend a guiding hand.

The problems of supplying blood for all patients needing it are legion. They vary with each community. In one instance a small hospital in a community near a large center may arrange with the large hospital in the center to provide blood from universal donors when needed. This task can become an impossible burden for the large hospital unless the citizenry of the small community is acquainted with its responsibilities to provide suitable donors in adequate numbers. The small isolated hospital in which fewer than ten transfusions are given each month may find it necessary to maintain an adequate roster of universal donors who are freely available on short notice. Under such circumstances small hospitals would do well to keep a supply of irradiated plasma, procured through commercial channels, on hand to augment their supply of blood. Banking "on the hoof" is not satisfactory and the problem will not be solved until the National Red Cross completes its program of blanketing the country with blood banks.

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† From Department of Anesthesiology, Hartford Hospital.
dispensing to all hospitals. This will require time and experience. In the interim many communities can solve their own problems locally.

When establishment of a blood bank is planned the first problems that arise are how much blood will be required and how will it be best to organize to supply it? Experience has demonstrated that a general hospital (2) with patients averaging ten days stay per admission will require from 5 to 6 pints of blood per bed per year. Approximately one out of every 7 or 8 patients admitted will need a blood transfusion as an average. It is, of course, true that certain patients will receive many times their share while others will need none.

A satisfactory blood bank may be operated for small hospitals by the use of only Group O blood. Theoretically, if blood from universal donors is treated with group-specific A and B substances it becomes truly universal. Wittebsky and Klendshoj (3) warned, however, that “addition of group specific substances cannot bring about any other change than the neutralization of the iso-antibodies present in blood fluid of Group O. There are still many sources of transfusion reactions that are obviously not influenced by the addition of group-specific substances to O blood.” Our experiences at Hartford Hospital substantiate this warning. Some states legally frown on employment of universal donors and stipulate group for group donations. Such a stipulation seems to be outside the realm of public interest, particularly when we consider that the number of recognizable groups has increased many fold in recent years. Use of Group O blood in hospitals where administrations average from 10 to 15 per month seems warranted.

In larger hospitals utilizing from 10 to 15 units of blood per week, to store Group A and Group O blood will permit acceptance of donors from 82 per cent (4) of the adult population. This type of bank was set up in the Mediterranean Theater of Operations, U. S. Army, during World War II. Acceptance of only Group O donors would have soon exhausted the available supply. Group O bloods under such circumstances can be given to all recipients and Group A bloods may be given to Groups A and AB recipients. Such an arrangement would, as in the smaller hospitals, require determination of each prospective donor’s group before blood is withdrawn.

Complete blood banks are warranted for hospitals having over 25 to 30 transfusions per week. Donors of all types may be accepted at the discretion of personnel operating the bank. Bloods kept beyond the agreed limit of storage need not be discarded completely. The supernatant plasma may be aspirated and stored in the frozen state. Originally this procedure was followed at Hartford Hospital but when surplus war stocks of plasma were made available the practice was discontinued. Now that it is advocated that plasma be irradiated to prevent occurrence of hepatitis, plasma from over-age blood is aspirated and turned over to the laboratory to be used in the preparation of media for bacteriologic purposes. It is to be noted that, in a busy
large hospital, particularly where, in addition, blood is being supplied to nearby smaller hospitals, blood seldom becomes outdated. The problem is to procure sufficient blood to meet the requirements of each week.

In order to assure procurement of a sufficient number of donors, several approaches to the problem may be employed. A comprehensive list of available professional donors of known blood groups may be kept. It will be necessary to offer sufficient remuneration per donation to attract donors. In a large city with a large floating population the price may be as low as $5. per 500 cc. of blood donated. The difficulty is to prevent the same donor presenting himself again for donation the same afternoon, then going out and spending his $10. riotously and eventually admitting him through the accident ward where he needs at least one transfusion for which he cannot pay. In smaller cities where the payment of $25. per 500 cc. of blood donated has become a tradition throughout the years the problem is to deal with college boys who may be under age and who will not freely admit it. Blood may be procured from outpatients suffering from polycythemia vera. The problem is whether to charge them for this form of therapy or pay them for the blood if it is Group O or A. Because the blood that they provide is high in content of hemoglobin our policy is to pay for such blood. Another method employed to assure a constant supply of blood is to interest civic groups included in churches, lodges, industrial plants and unions to establish credits in blood donated by each group for the benefit of individuals in each group who may subsequently need a transfusion. Donors presenting themselves must bear an authorization from the secretary of the group to show that they are bona fide donors of the group seeking credit. Debits are made only on the authorization of the secretary of a group to which the patient belongs. The bank should not be expected to assume such responsibility without authorization. Any bank transgressing this principle will soon be in difficulty on the basis of public relations. Patients may enlist the donation of blood by friends or relatives to repay the bank for blood administered. Interns, residents and physicians in charge of patients should be urged to bring this possibility of repayment in kind to the attention of each patient receiving a transfusion or to his responsible relative. Because this phase of blood banking may be fulfilled haphazardly it is our policy to have the intravenous therapist leave with each patient who has a transfusion a statement of the fact that the blood bank welcomes repayment in kind but reserves the right to reject donors who cannot provide blood of the groups needed on the day they present themselves. They are asked to return another day after inquiring by telephone if their particular type can be accepted. Some hospitals require repayment in kind on the basis of two donations for each donation administered. It is our practice to consider blood a pharmaceutical commodity for which, in every instance, a charge is put through to the business.
office for each transfusion given. A charge for service rendered is added. A credit for the amount equal to the original cost of the blood is put through to the business office for each unit of blood donated in repayment by friends and relatives. In this fashion the patient may pay off his whole bill, provided that his replacement donors meet the blood bank’s criteria and needs of the moment. It is well to explain that at Hartford Hospital interns, residents or attending physicians cannot establish a credit for patients on their particular service. Maintenance of blood of suitable types in the bank is the responsibility of personnel in charge and professional donors are called at their discretion to keep the bank supplied in balanced fashion in so far as blood groups are concerned. Each patient is transfused on a physician’s order without reference to any credit that physicians might, in some localities, be required to maintain with the bank. Under these circumstances there is no question about a patient being given a transfusion immediately if he needs blood. If a patient on discharge from the hospital is unable to pay his whole bill, it is adjusted or arrangements are made for its collection. If a loss is sustained the blood bank bears only its pro rata share.

Criteria for selection of donors must be established. Donors of suitable blood groups are accepted from either sex if they are over 21 and under 55 years of age. Otherwise suitable donors between the ages of 18 and 21 are accepted if they have written permission from their parents or guardian to donate. Oral temperature must not exceed 98.6° F. The value of hemoglobin must exceed 80 per cent of normal and the systolic blood pressure must be in the range between 100 and 200 mm. of mercury. Each donor must be free of tuberculosis, syphilis, symptom-free of malaria for two years without use of suppressive drugs, and symptom-free of jaundice for at least two years. Married women are not accepted if their youngest child is under one year of age. Donors must not have undergone a surgical procedure within the past six months. Alcoholics are not accepted unless an accurate history of sobriety for twenty-four hours is elicited. Asthmatics are not accepted but donors with a history of hay fever may be used when symptom-free. Repeated attacks of angioneurotic edema should disqualify a prospective donor. Donors are advised to avoid food for four hours prior to bleeding but during this interval coffee, tea or other simple liquids of innocuous nature may be imbibed and, as a matter of fact, this is advised. It is a safe rule to allow the withdrawal of not more than 500 cc. of blood at any one time. The procedure is not repeated until ninety days have elapsed.

Before attempting to establish a blood bank one should be assured of a source of pyrogen-free fluid for intravenous use. Most small hospitals find this a relatively simple matter now that commercial firms can supply bottles prepared for collecting blood with the anticoagulant solution contained under a partial vacuum.
Companion sets of a disposable nature for administration of blood are available commercially. Larger hospitals averaging over 25 transfusions per week and a correspondingly larger number of administrations of intravenous fluids per week might well investigate the possibilities of manufacturing their own intravenous fluids and of preparation of bottles for collection of blood. At the time Hartford Hospital started blood banking, we had no alternative but to employ locally manufactured fluids and sets that were processed on the premises. Commercial firms were able to supply prepared collecting bottles for blood but disposable sets were not available. It was, therefore, mandatory that sets be processed on the premises. Under these circumstances, when pyrogen reactions occur it is practically impossible to trace the source of error, establish responsibility and institute remedial measures. For these reasons we elected to establish a completely integrated blood transfusion and intravenous service within the hospital. In the early days of its operation blood was collected by members of the Department of Anesthesiology, grouped and cross matched by members of the Department of Pathology and administered in the main by interns. Preparation of sets and manufacture of crystalloid solutions were done by a group of nurses. This system worked poorly because of lack of centralized control. As the volume of work increased and with the advent of the draft in 1941 a shortage of interns developed. It was decided to centralize the work within one group of workers. Nurses were taught the technic of manufacture of fluids, preparation of sets, procurement of blood from donors and administration to recipients after properly grouping and cross matching it. A subsequent increase in work necessitated a split of these forces into two groups. To one group was delegated the manufacture of fluids and the processing of sets. This group was put under the control of a graduate nurse thoroughly indoctrinated with the importance of maintaining untoward reactions at a minimum. She in turn selected a group of lay workers to perform the tasks assigned to her. A set of procedures was established (Appendix A). It was stressed that from the time the washing of bottles was started or cleaning and processing of component parts of intravenous sets was begun, not more than three hours should elapse before autoclaving was begun. It was demonstrated that enforcement of this policy was responsible for a drastic reduction in pyrogenic reactions. The second group of nurses was made responsible for the intravenous administration of fluids throughout the hospital from 8 a.m. to 7 p.m. each day. In addition, they were directly responsible for the procurement of donors, collection of blood, grouping and cross matching and administration to recipients. Administrative control of both groups was made the responsibility of the Chief of the Department of Anesthesiology with the Chief of the Department of Pathology acting in an advisory capacity regarding the technicalities of grouping and cross matching of blood. This system has worked
well. It lends itself to easy expansion to meet needs. We have been fortunate enough to retain the services of responsible nurses over relatively long periods of time. Because the work requires meticulous attention to detail it is easy to envisage the weakness of the system if personnel were constantly changing. The work is attractive to nurses and lay personnel because they realize that success of the service is a direct measure of their efficiency. They are constantly faced with a challenge and, because of that, their interest is constantly maintained and their efficient work reflects that interest. Were this not so, the Chief of the Department of Anesthesiology would soon become prematurely aged, with worry as a prime cause.

Realizing the interest of selected personnel in all the intricacies of blood banking and intravenous therapy, within the past two years a postgraduate course for the training of nurses has been set up and approved by the Connecticut State Department of Education and by the Veterans Administration in relation to the G. I. Bill of Rights. A new student is accepted every second month for six months' training. Although the quota of students is six per year we have had inquiries or applications or both from 100 nurses in the last ten months. Trainees are taught all phases of blood banking and intravenous therapy. Lectures covering the technical phases are given and, in addition, medical and surgical seminars are attended. Employment for these specialists is not assured but as the National Red Cross continues to set up blood banks throughout the country it is our belief that the services of these specialists will be more and more in demand.

Two rooms are assigned to the blood bank. They are in close proximity to the Department of Pathology and one floor below the operating rooms. One room is equipped with two tables for bleeding donors, two cots for recovery of donors should they exhibit symptoms of syncope and a refrigerator of standard commercial type capable of maintaining a temperature of 4 C. Blood is taken through a 15 gauge needle and delivered by gravity into a flask containing A.C.D. solution and glass beads. The flask is marked with the donor's name, type and date of collection. Two pilot tubes containing samples of blood for subsequent cross matching are attached. It is stored in refrigerator A until serologic tests establish the blood as syphilis-free. With this information noted, the blood is then moved into the second room which is the blood bank proper where it is stored in refrigerator B. The blood type and Rh factor are rechecked while it remains in this refrigerator, which is kept locked under the control of the senior blood banker. After bloods are completely identified as Group O Rh negative or positive, they are moved to refrigerator C which is always kept unlocked. Flasks containing Group O Rh negative blood are stored on the top shelf of refrigerator C. The second shelf contains flasks of blood identified as Group O Rh positive. The third or lowest shelf holds blood reserved for specific patients when cross matching has
been completed. Blood from these three shelves in refrigerator C is always available for residents to procure during the night for administration in emergency. Blood from shelves one and two may be given in emergency without cross matching if need be.

A resident removing blood from refrigerator C during the night removes the bank’s control card from the bottle and indicates the name, hospital number and location of the patient to receive it. To this card he signs his own name. Next morning the personnel of the bank check these cards and if, in fact, the patient received the blood, they issue a charge slip which is sent to the business office for notation on the patient’s account. In addition, they check the data that the resident may have put, or failed to put, on the patient’s chart. Residents failing to cooperate in routines are reported, after sufficient warning, to the Medical Director of Education for disciplinary action.

When a routine transfusion is ordered, the physician makes out a transfusion request slip stamped by addressograph with the patient’s name, address, hospital number, ward and responsible physician recorded. The slip is sent to the blood bank with a sample of blood for typing and cross matching. The blood banker identifies the blood suitable for the recipient and it is issued to the intravenous therapist with the request slip attached but now containing the name of the donor and his type. Double checking of the cross match is recorded. As previously noted for residents acting in the capacity of therapist, the bank’s control card is retained in the bank and a charge slip is sent to the business office. The intravenous therapist gives the blood and, having checked on the request slip the amount given and elapsed time of administration, she attaches the request slip in the patient’s clinical record.

The patient or his relatives may arrange for nonprofessional donors to repay the bank in kind. If they are accepted and blood is taken, a credit slip is issued and sent to the business office for adjustment of the patient’s account. As many donors as the bank may need are accepted in this fashion. If payments in kind are insufficient to maintain stocks of the bank, the banker calls in professional donors to correct the situation. After each professional donor’s blood is withdrawn he is issued an order for payment in cash. This order he presents to the cashier.

As the name implies, intravenous therapists are responsible not only for the blood bank but also for the administration of intravenous fluids to patients throughout the hospital. They use the blood bank as a call center for all administrations not given on regular rounds of the wards. The presence of this highly trained group has greatly facilitated the efficiency with which these therapeutic procedures have been effected. Confidential reports from discharged patients frequently contain expressions of satisfaction with the service rendered. The interns and residents are well satisfied to be freed from these responsi-
bilities because their time can be occupied to better advantage in diagnostic experiences. In the event of major civilian disasters, these experts in the production of fluids and in the technic of venipuncture have provided physicians invaluable assistance. We have never been short of materials or supplies.

**Comment**

A comprehensive organization for manufacture of intravenous fluids, collection, storage and issue of blood and administration of all fluids by the intravenous route must be controlled by a responsible individual. Otherwise, when difficulties are encountered, application of remedial measures lags during establishment of responsibility for faults. The system to be a success hinges upon standardization of equipment and procedures in utilization of it. Equipment for administration of crystalloids must be freely adaptable to the administration of blood or both crystalloids and blood simultaneously. Intravenous therapy is best limited to a small group of specialists within the institution. The intravenous therapist must have the support of a senior staff member. It is his duty to regulate application of standard practices and, on occasion, consult with physicians and surgeons regarding dosage and timing of therapy ordered by them.

An outline of methods employed to facilitate and regulate intravenous therapy has been presented. The organization has served its purpose well. It is recognized that it is not universally applicable without alteration. Since fluids can be manufactured for approximately half the cost of fluids procured through commercial channels, the savings have been well spent in hiring and training of nurses as intravenous therapists. This is feasible in a large hospital in which the volume of work (tables 1 and 2) is large enough to warrant manufacture of fluids and processing of sets. We have not been impressed with new developments in disposable sets. We shall await their improvement, standardization and reduction in cost in the hope that in the meantime the National Red Cross will establish banks throughout the country supplied by volunteer donors.

**TABLE 1**

**Hartford Hospital**
**Annual Report**
October 1, 1947 to September 30, 1948

<table>
<thead>
<tr>
<th>Donors</th>
<th>Total</th>
<th>Professional</th>
<th>Replacement</th>
<th>Therapy</th>
<th>Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5528</td>
<td>1967</td>
<td>2568</td>
<td>95</td>
<td>4553</td>
</tr>
</tbody>
</table>

Inadequate 898

<table>
<thead>
<tr>
<th>Recipients</th>
<th>Donors</th>
<th>Plasma</th>
<th>Canceled</th>
<th>Transfusions Given</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordem</td>
<td>5956</td>
<td>290</td>
<td>866</td>
<td>4500</td>
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</tbody>
</table>
TABLE 2
HARTFORD HOSPITAL
ANNUAL REPORT
October 1, 1947 to September 30, 1948

Processed

<table>
<thead>
<tr>
<th>Sets</th>
<th>Previous Year</th>
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</thead>
<tbody>
<tr>
<td>40,618</td>
<td>34,154</td>
</tr>
</tbody>
</table>

Manufactured

<table>
<thead>
<tr>
<th>Flasks: Solutions</th>
<th>Previous Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>69,683</td>
<td>59,932</td>
</tr>
</tbody>
</table>

REFERENCES


APPENDIX A
MANUFACTURE OF SOLUTIONS
FOR INTRAVENOUS ADMINISTRATION

Sets

All used intravenous sets must be returned to the Solution Room daily from 7 a.m. to 9 a.m. only. The number of the ward to which a set has been issued must be placed by the ward on the outermost wrapper of that set.

Each set will be inspected on return. All parts missing from a set must be replaced immediately by the ward to which the set was issued.

At the end of each day the used sets are completely dismantled. All parts are again checked and counted; worn rubber tubing and broken parts are replaced to make each set complete.

The glassware and rubber tubing are placed in separate basins. Sufficient calgolic solution (30 cc. of calgolic powder to 4000 cc. of tap water) is poured into each basin to cover the contents. Each basin and its contents are then autoclaved for one minute at 15 pounds pressure. The glassware and rubber tubing are allowed to stand overnight in the solution. The tubing must be free of kinks.

The next morning the following routine is observed:

1. Drain basin containing glassware and rubber tubing; rinse basin and contents with hot tap water.
2. Force hot tap water through each piece of tubing on the four-outlet manifold.
3. Force hot tap water through each end of each piece of glassware.
4. Pass distilled water by suction through each piece of tubing and glassware (distilled water within 3 hours of preparation).
5. Stand glassware on drain board until needed; cover to keep free from dust.
6. Place rubber tubing in a basin which has been rinsed with distilled water.
7. Assemble all sets as requested.
8. a. Wrap each set in a towel.
   b. Wrap and tie each set as in (a) in an outer large wrapper or "do-up."
   c. Mark and date each set thus wrapped.
9. Autoclave for 20 minutes at 20 pounds pressure. (All sets must be placed in the autoclave within 2½ to 3 hours after the last rinsing with distilled water.)

Needles

1. Soak all used needles in clean cold water overnight.
2. In a.m. clean hubs on electric hub machine.
3. Pass a wire through each needle to insure patency of the needle.
4. Wash on needle washing machine with soap, water and ether.
5. Inspect the point of each needle; sharpen when necessary.
6. Place needles in glass jars for storage.
7. The next morning the needles to be used during the day are removed from the jars.
8. Force ether through each needle.
9. Place each needle in a 3 inch x 3 inch gauze.
10. Place each needle thus wrapped within the towel of the proper set.

Solutions

All used flasks and blood bottles must be returned to the Solution Room daily from 7 a.m. to 9 a.m. only.
The following routine is observed with each flask or blood bottle:

1. Remove steel cap, rubber bushing and label.
2. Rinse outer surface of bottle with hot tap water.
3. Invert bottle on Fenwal rinser and flush inner surface three times with hot tap water.
4. Place bottle in tub containing hot calgolac solution, allowing at least 3 to 5 minutes in this bath for each bottle.
5. With a long-handled brush, wash inner surface of bottle with calgolac solution and remove bottle from tub.
6. Rinse outer surface of bottle with hot tap water.
7. Invert bottle on Fenwal rinser and flush three times with hot tap water.
8. Invert bottle on the Fenwal rinser which is attached to the distilled water bottle (10 gallon capacity) and flush three times with distilled water (about 100 cc. for each rinsing).
9. Inspect each bottle for nicks and cracks.
10. Place bottle on drain peg for immediate use.
11. a. Brush and wash clean each steel cap and rubber bushing in hot tap water.
   b. Place each cap and bushing in calgolac solution for 5 minutes.
   c. Rinse each twice in hot tap water.
Organization and Operation of a Blood Bank

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d. Rinse each twice in distilled water before use.
Caps and bushings may remain overnight, if necessary, in fresh distilled water. They must be rinsed again with fresh distilled water the next morning before use.

12. a. Fill each bottle with the desired solutions; label appropriately having taken the following precautions:
Check all labels at three stages for identification of each batch of solution:
1. When counting out 21 for each batch, inspect for wear and tear and accuracy of label.
2. When stamping label with date of manufacture of fluid.
3. When placing labels on flask of any one batch.

13. Place rubber bushing on bottle (the bushing must be fitted tightly).
14. Insert steel cap part way (this will allow steam to escape through the small groove in the stem of the cap during autoclaving).
15. Autoclave bottles for 20 minutes at 20 pounds pressure. All bottles must be placed in the autoclave within 2½ to 3 hours after the last rinsing with distilled water.

16. Immediately following the removal of bottles from the autoclave, push the steel cap of each bottle tightly into place.

Note: Following autoclaving, the solutions remain sterile if the vacuum is preserved.

Equipment

1. All utensils employed for measuring, mixing and bottling of solutions must be rinsed with distilled water each morning before use and each day following use.
2. All utensils used for manufacture of dextrose or saline solutions must be rinsed thoroughly with distilled water when changing from production of one type of solution to the other.
3. Twice each week, on Tuesday and Friday, all equipment must be cleaned with calgolac solution and rinsed, employing the technic used for bottles or flasks.
4. The glass reservoir of the "still" and all storage bottles for distilled water (the latter of 10 gallon capacity) must be drained at the end of each day.

Preparation of Solutions

Stock (concentrated) Solutions

To make:
I. Sodium chloride 3.75% in distilled water:
   Dissolve 150 Gm. of sodium chloride in 4000 cc. of distilled water.
II. Sodium chloride 3.75% + dextrose 15.0% in distilled water:
   Dissolve 150 Gm. of sodium chloride and 600 Gm. of anhydrous dextrose in 4000 cc. distilled water.
III. Sodium chloride 3.75% + dextrose 25% in distilled water:
   Dissolve 150 Gm. of sodium chloride and 1000 Gm. of anhydrous dextrose in 4000 cc. distilled water.
IV. Sodium chloride 3.75% + dextrose 50% in distilled water:
Dissolve 150 Gm. of sodium chloride and 2000 Gm. of anhydrous dextrose in 4000 cc. distilled water.

V. Dextrose 15.0% in distilled water:
Dissolve 600 Gm. of anhydrous dextrose in 4000 cc. of distilled water.

VI. Dextrose 25% in distilled water:
Dissolve 1000 Gm. of anhydrous dextrose in 4000 cc. of distilled water.

VII. Dextrose 50% in distilled water:
Dissolve 2000 Gm. of anhydrous dextrose in 4000 cc. of distilled water.

The equipment needed will be: two graduates of 4000 cc. capacity each; one graduate of 1000 cc. capacity; graduates or beakers to contain the solutes in accurately weighed amounts; one solid glass stirring-rod.

The following procedure may be employed for the preparation of stock solutions:

1. Fill 4000 cc. graduate to 2000 cc. mark with freshly distilled water.
2. Add ingredients necessary to make the solution desired, stirring until all are dissolved.
3. Add distilled water to 4000 cc. mark.

In preparing stock solutions containing both sodium chloride and dextrose, the following sequence should be observed:

1. Check distilled water by tasting a sample obtained with a glass rod from the 4000 cc. graduate.
2. a. Add sodium chloride in desired amount to distilled water.
   b. If desired, add glucose.
   c. Check mixture by tasting a second sample at this stage.
3. Warm the mixture by placing graduate on hot plate.
4. Prior to filtration of warm stock solution make third check by tasting a sample.

Preparation, from Stock Solutions, of the Solutions Used for Intravenous Therapy

1. Filter the stock solution through a fretted glass filter.
2. a. Place 350 cc. of stock solution in each flask intended for the final product (the solution which is to be administered by the intravenous route).
   b. Add 1200 cc. of freshly distilled water, to make 1550 cc. The extra 50 cc. are allowed for evaporation during autoclaving and for removal of air from the tubing used in administration of the solution.

3. To make:
   a. Sodium chloride 0.85% in distilled water (normal saline). Use stock solution I, employing the procedure stated in (1) and (2) above.
   b. Dextrose 3% in 0.85% saline solution. Use stock solution II.
   c. Dextrose 5% in 0.85% saline solution. Use stock solution III.
   d. Dextrose 10% in 0.85% saline solution. Use stock solution IV.

* For this purpose, an automatic mixing device is used.
† The stated quantities are sufficiently accurate for practical purposes.
e. Dextrose 3% in distilled water. Use stock solution V.
f. Dextrose 5% in distilled water. Use stock solution VI.
g. Dextrose 10% indistilled water. Use stock solution VII.

Each 4000 cc. amount of stock solution, when dispensed and diluted as in (1) and (2) above, will make eleven (11) 1550 cc. portions of the final solution desired for intravenous use.

Stock solution VI (dextrose 25% in distilled water) is used either for dilution to dextrose 5% in distilled water or is employed as the original product (25%) for intravenous use.

Preparation of A. C. D. Solution

The following are the ingredients used:

\[
\begin{align*}
\text{Sodium citrate} & \quad \text{26.66 Gm.} \\
\text{Acid citric} & \quad \text{9.50 Gm.} \\
\text{Anhydrous dextrose} & \quad \text{60.00 Gm.}
\end{align*}
\]

Using a beaker or graduate of 2000 cc. capacity, place the stated amounts of the above in the container; add freshly distilled water to 2000 cc., stirring slowly. Be sure all ingredients are completely dissolved. To dispense this solution to prepared blood bottles:

a. Filter the solution.
b. Add 150 cc. of this solution to each blood bottle (650 cc. capacity).
c. Add 1 level medicine-glassful of glass beads to each blood bottle. Cap these bottles and autoclave within 3 hours, as described in previous sections entitled "Solutions."

RALPH M. TOVELL, M.D.
ALICE D. WILLIAMSON, R.N.

Hartford Hospital
Hartford, Connecticut
November 1, 1947