Principles and Practice of Intravenous Therapy

Second Edition

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Preface

This book has been revised to meet the needs of the nurse, the medical student, the house officer, and all personnel who share the responsibility for intravenous therapy. It presents a source of practical information essential to safe and successful therapy.

In the past, intravenous therapy consisted chiefly of supplying necessary fluid to the fasting patient. Today it is much more complex and involved. Its use is extensive, and it is now an integral part of the daily treatment of medical and surgical patients. Frequently it is a lifesaving procedure; safe and successful therapy is essential and demands special knowledge and skill. Yet in spite of the increasing use and importance of parenteral therapy, little training is required of the average therapist to carry it out. It is considered sufficient by some that the therapist be able to perform a venipuncture. This modicum of knowledge does not contribute to the optimal care of the patient whose prognosis depends upon intravenous therapy, nor does it comply with legal requirements. The joint policy statements of most states require that the registered nurse be qualified by education and experience, but the majority of nurses have not been schooled in intravenous therapy in their basic or continuing education programs since most nursing schools do not include it in their curriculum. In order to perform intravenous therapy legally, nurses must seek this knowledge.

The medical staff also requires education and training. The medical student, on joining the hospital staff, is automatically expected to draw blood samples, insert intravenous cannulas, and start infusions. Techniques of venipuncture learned on a trial-and-error basis result in trauma to the veins; faulty handling of equipment and lack of aseptic technique contribute to serious complications. The house officer is required to insert catheters into the vena cava for central venous pressure monitoring and to perform therapeutic phlebotomies and many other related procedures.

Much has been published concerning cases of septicemia and fungemia which have been traced to in-use intravenous apparatus. Studies

show that hospital personnel lack an understanding of asepsis and poorly carry out antiseptic practices.

Particulate matter infused through intravenous fluids may produce pathological changes that could adversely affect critically ill patients. For example, glass ampules may be the source of injection of thousands of glass particles into the circulation. Personnel directly involved in intravenous therapy remain ignorant of these dangers; yet it is their professional and moral responsibility to ensure that the patient receives fluids free from bacterial, fungal, and particulate contamination. This book provides information on these potential hazards and on the official recommendations for their prevention.

Our knowledge of fluid and electrolyte balance has increased; we now recognize an imbalance as a threat to life—a potential danger to the patient. This understanding has brought about an increase in the use of intravenous therapy and thus in the responsibility of the nurse. Knowledge of the fundamental concepts governing fluid and electrolyte balance contributes to safe therapy; knowledge of the endocrine response to stress assists the nurse in a better understanding of imbalances and problems associated with them. The nurse becomes alert to potential fluid and electrolyte disturbances, how they develop, and symptoms by which they are recognized.

Rapid and critical changes in fluid and electrolyte balance may be caused by the improper administration of intravenous fluids. Yet intravenous fluids, in spite of wide use, are the least understood of any vehicle used in the treatment of the hospitalized patient. Five percent dextrose in water, once considered a safe fluid, is now used more cautiously and recognized for the imbalances it may cause. The chapter titled *Parenteral Fluids and Related Fluid and Electrolyte Abnormalities* provides vital information for all personnel involved in the care of the patient receiving intravenous therapy.

Total parenteral nutrition has become a vital therapy in preventing starvation in many critically ill patients. Yet serious life-threatening complications may result from the care of these patients by untrained personnel.

Advances in drug therapy have further complicated intravenous therapy. The venous route offers pronounced benefits but is accompanied by problems and complications that are nonexistent in other forms of drug therapy. Very often the responsibility of compounding intravenous additives is left entirely to the nurse. With the continuous increase in drug products and parenteral fluids, the number of possible drug combinations is astronomical. This increases the likelihood of potential incompatibilities. Some basic knowledge should be available to those who share this responsibility.

Blood administration is an integral part of intravenous therapy.

Rapid advancement in transfusion therapy increases responsibility for administering this vital fluid. The therapist shares responsibility for safe administration. She must know the disadvantages as well as the advantages associated with blood and its components; she must be trained in the proper handling of blood and the basic principles of its safe administration. Knowledge of the fundamental principles of immunohematology provides a basis for understanding the problems associated with blood administration. It alerts the nurse to potential reactions, why they develop, and symptoms by which they are identified.

No matter what type of therapy is involved, an understanding of the basic principles of safe fluid administration is vital. With any infusion there is a certain element of risk. The therapist and the nurse involved in fluid maintenance must know the potential hazards and how to prevent their occurrence.

The patient's prognosis may depend upon his ability to receive a prolonged course of therapy. Preservation of the veins is important. Intravenous therapy may be given almost indefinitely if the therapist is skillful in (1) the choice of veins, (2) technique, and (3) the selection of proper equipment. The efficiency of the therapist may obviate the need of venous cut-downs and preclude the risk of adding the complication of thrombophlebitis to present illness.

With the increased use of intravenous therapy, there is a definite need for parenteral teams. More and more hospitals are establishing intravenous departments. In addition to the techniques and training essential to their function, this book also provides information on the organization of a team of intravenous nurses and the various duties that can be performed by this specialized group.

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1. History of Intravenous Therapy

The idea of injecting various substances, including blood, into the circulatory system is not new; it has been in the mind of man for centuries. In 1628 William Harvey's discovery of the circulation of the blood stimulated increased experimentation. In 1656 Sir Christopher Wren, with a quill and bladder, injected opium intravenously into dogs, and 6 years later, J. D. Major made the first successful injection in man [8].

In 1665 an animal near death from loss of blood was restored by infusion of blood from another animal. In 1667 a 15-year-old Parisian boy was the first human being to receive a transfusion successfully; lamb's blood was administered directly into the circulation by Jean Baptiste Denis, physician to Louis XIV [8]. The enthusiasm aroused by this success led to promiscuous transfusions of blood from animals to man with fatal results, and in 1687 by an edict of church and parliament animal-to-man transfusions were prohibited in Europe.

About 150 years passed before serious attempts were again made to inject blood into man. James Blundell, an English obstetrician, revived the idea. In 1834, saving the lives of many women threatened by hemorrhage during childbirth, he proved that animal blood was unfit to inject into man and that only human blood was safe. Nevertheless complications persisted; infections developed in donor and recipient. With the discovery of the principles of antisepsis by Pasteur and Lister, another obstacle was overcome, yet reactions and deaths continued.

In 1900 Karl Landsteiner proved that not all human blood is alike; classifications were made [8]. In 1914 a chemical, sodium citrate, was found to prevent blood from clotting [8]. From then on rapid advance has taken place.

Administration of parenteral fluids by the intravenous route has become widely used only during the past thirty-five years. The difficulty in accepting this procedure was due to lack of safe solutions. The solutions used contained substances called pyrogens, proteins which are foreign to the body and not destroyed by sterilization. These caused

chills and fever when injected into the circulation. About 1923, with the discovery and elimination of these pyrogens, the administration of parenteral fluids intravenously became safer and more frequent.

Until 1925 the most frequently used parenteral solution was normal saline solution. Water, because of its hypotonicity, could not be administered intravenously and had to be made isotonic; sodium chloride achieved this effect [5]. After 1925 dextrose was used extensively to make isotonic solutions and to provide a source of calories [5].

In the early 1930s administration of an intravenous injection was a major procedure reserved for the critically ill patient. The doctor performed the venipuncture assisted by a nurse. The success of intravenous therapy and the great increase in its use led to the establishment of a department of specially trained personnel for infusion therapy. In 1940 the Massachusetts General Hospital became one of the first hospitals to assign a nurse as Intravenous Therapist. The services of the intravenous nurse consisted in administering intravenous solutions and transfusions, cleaning infusion sets, and cleaning and sharpening needles. Emphasis was placed on the technical responsibility of maintaining the infusion and keeping the needle patent. The sole requisite of the intravenous nurse was the ability to perform a venipuncture skillfully.

As knowledge of electrolyte and fluid therapy grew, more solutions became available, and further knowledge was needed to monitor the fluid and electrolyte status of the patient. Normal saline was no longer the only electrolyte solution. Today over 200 commercially prepared intravenous fluids are available to meet every need of the patient.

A whole new approach to intravenous therapy and a respite to the starving patient evolved in 1965 when members of the Harrison Department of Surgical Research at the University of Pennsylvania showed that sufficient nutrients could be given to juvenile beagle dogs to support normal growth and development [4]. This led to what is known today as total parenteral nutrition.

Improvements and innovations in equipment have reduced hazards; sets and needles are now disposable, reducing risks of pyrogenic reactions and hepatitis. Prior to the Second World War, the metal needle was used extensively for infusing parenteral fluids. Frequent infiltrations as well as difficulties with the metal needle led to the development in 1945 of the flexible plastic tubing known as the intravenous catheter [3]. This tubing was introduced into the circulation by means of either a cut-down or a needle. These procedures were cumbersome and required the same aseptic techniques as a small surgical procedure. In 1952 Aubaniac [1] first described the percutaneous approach to the subclavian vein, a procedure vital for monitoring the central venous pressure. Today this procedure has been applied to administering total

parenteral nutrition. In 1958 the Intracath,* a plastic catheter lying within the lumen of the needle, was introduced in individual sterile packaging [2]. This type of catheter has reduced the need for the surgical procedure, the cut-down. At about the same time, a new innovation of the catheter, the Rochester needle,† was introduced by Emil Gauthier, Head of Rochester Products Company, and David John Massa, Anesthesiologist at the Mayo Clinic. This consists of a resinous catheter on the outside of a steel needle [7]; the catheter is slipped off the needle into the vein and the needle removed.

The catheter is invaluable in lifesaving procedures; nevertheless serious complications have been documented in the use of both the percutaneous and the surgically placed catheter. Intravenous therapy was fast changing from a purely technical responsibility to one that required a broad range of knowledge. The first change in the steel needle appeared in 1957 when McGaw Laboratories introduced the first grips made out of rubber and looking like an inverted T on a small needle. Shortly after this, small vein sets appeared with foldable wings replacing the metal hub. The traditional steel needle gave way to the winged infusion needle since the latter provided more comfort and was less apt to infiltrate.

In spite of all the advances in scientific and medical technology, complications have increased to alarming proportions. Our knowledge must now include the prevention of bacterial, fungal, and particulate contamination. Industry continues to provide equipment to increase the level of patient safety. Today filters are available which limit access of particulate matter, bacteria, and fungus to the bloodstream. Proper handling and use of this equipment are vital to the patient's safety.

Until recently the subcutaneous and the intramuscular routes were preferred for the parenteral administration of drugs. Today medications are commonly given intravenously, with 60 to 80 percent of infusion fluids containing additives.

Transfusion therapy has moved ahead by leaps and bounds. Not until 1940 did Karl Landsteiner and Alexander Wiener discover the Rhesus system. By 1968 RhoGAM had been manufactured and made available to the physician. RhoGAM relegates Rh hemolytic disease to a disease of the past [6].

Intravenous therapy has come a long way since the 1940s when the sole requisite of the intravenous nurse was the ability to perform a venipuncture skillfully. The value of the intravenous specialist is evidenced by the increasing numbers of parenteral teams and professional organizations throughout the United States. These organizations provide a forum for the interchange of ideas, information, experience, and

* Deseret Pharmaceutical Co., Inc., Sandy, Utah.
† Formerly, Rochester Products Co., now a Jelco Division of Johnson & Johnson.

knowledge, with the ultimate goal of raising standards and increasing the level of patient care.

We have reached a new, exciting era in intravenous therapy, one that has become complicated by great technical advances and spectacular medical and surgical achievements.

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