

EFFECT OF EXPERIENCE IN VENIPUNCTURE
ON FREQUENCY OF INFILTRATION

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We hereby recommend that the thesis prepared under
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DEDICATION

To my mother, Mrs. Eathel Goodman, who
instilled within me her great respect for
education, this work is lovingly dedicated.

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CHAPTER I

INTRODUCTION

Intravenous therapy has increased to the point where it is one of the most frequently administered treatments in hospitals.¹ Maki, Goldman, and Rhame estimate that over one-fourth of hospitalized patients in the United States--over eight million Americans--receive intravenous infusions annually.² This type of therapy has been described as "the fastest, most effective way to help the body re-establish homeostasis."³ A recent survey of doctors and intravenous nursing specialists reported the following reasons for using parenteral fluids:

- ___ Rehydrating cells, providing fluid for urine
- ___ Restoring extracellular fluid volume
- ___ Restoring blood volume
- ___ Supplying calories to the unfed patient to minimize catabolism, particularly post-operatively
- ___ Correcting specific electrolyte disturbances in acidosis or alkalosis
- ___ Administering drugs: antibiotics, anesthetics, narcotics, sedatives, vitamins or other additives.⁴

¹Charlotte Isler, "I.V. Therapy: The Hidden Dangers," RN 36 (October 1973):23.

²Dennis G. Maki, Donald A. Goldman, and Frank S. Rhame, "Infection Control in Intravenous Therapy," Annals of Internal Medicine 79 (December 1973):867.

³Virginia B. Moore, "I.V. Fluids," Nursing '73 3 (June 1973):33.

⁴Ibid.

As the growth of intravenous therapy (I.V.) has increased, so has the role of the nurse expanded in the administration of these fluids. Her assumption of this responsibility has been questioned legally and professionally, but more and more hospitals are increasingly involving the nurse. Recognizing the need for special skills and knowledge in intravenous therapy, many hospitals organized parenteral teams, but as the practice of intravenous injections became more commonplace staff nurses were also utilized for this seemingly simple procedure.¹ Mutton warns that intravenous infusions can be life-saving or they can be life-endangering.² Maki, Goldman, and Rhame point out that "the intravenous infusion has never been as safe in practice as it has seemed to be in principle."³

. . . there are serious potential hazards inherent in I.V. therapy that were not fully recognized at first or have developed with the introduction of I.V. techniques, equipment, and drugs, and the increase of I.V. drug and fluid use. Every aspect of I.V. therapy is now under review: equipment, techniques of starting and maintaining I.V.'s, and the administration of drugs and solutions.⁴

¹Ada L. Plumer, Principles and Practices of Intravenous Therapy (Boston: Little, Brown and Co., 1970), pp. 2-3.

²Colin J. Mutton, "The Management of I.V. Infusions," Nursing Times 69 (24 May 1973):671.

³Maki, Goldman, and Rhame, "Infection Control in Intravenous Therapy," p. 867.

⁴Isler, "I.V. Therapy: The Hidden Dangers," p. 23.

Isler, in October 1973, presented the view that intravenous therapy is a field of specialty and that only specially skilled and knowledgeable nurses should be responsible for intravenous injections of fluids.¹

The most frequently occurring complication of I.V. therapy is infiltration, usually evidenced by swelling at the site of infusion. "This may arise from dislodgement of the needle or cannula from the vein while the infusion is in progress or from obstruction proximal to the site of infusion . . . leading to venous congestion and extravasation leakage into tissue."² If this occurs, it necessitates discontinuance of the infusion and re-injection in another site if therapy is to be continued. With each re-injection, hazards of vein irritation, inflammation, and infection are increased.³ If hypertonic, acid, or alkaline solutions are allowed to infiltrate, tissue necrosis can result.⁴

"With all the irritating substances intended for intravenous use, extravasation should be prevented, absolutely."⁵ (*Italics mine.*) The clinical literature has

¹Ibid., p. 26.

²Colin J. Mutton, "The Management of I.V. Infusions," Nursing Times 69 (31 May 1973):701.

³Ibid.

⁴Plumer, Principles and Practices of Intravenous Therapy, p. 77.

⁵Daniel F. Moravec, "A Review of Pharmacy for Nurses," Hospital Management 106 (July 1968):79.

suggested various factors associated with the avoidance of infiltration. Some technical aspects studied have been needle gauge and length, method of taping the needle, and site and length of infusion.¹ This investigator was unable to find any studies relating experience in performing the technique to frequency of infiltration.

Statement of the Problem

In reviewing the literature, it was noted that the reported studies of intravenous complications used intravenous teams in collection of their data. Sylvester and Bruno and Landry studied factors that were dependent on skill and knowledge of the person starting the infusion. "Skill in performing the venipuncture varied with the individual therapist on the intravenous therapy team and could have influenced the success of the venipuncture initiating the infusion."² Maki, Goldman, and Rhame pointed out, "No study has directly compared, by random allocation, the complications of infusions maintained by a team and by ward personnel."³ In theory, expertise in I.V. therapy is

¹Marilyn Sylvester and Pauline M. Bruno, "Factors Associated with Infiltration During Continuous Intravenous Therapy," Nursing Research 15 (Summer 1966):255.

²Marjorie Landry, "Factors Related to Infiltration During Continuous Intravenous Therapy" (Master's thesis, Texas Woman's University, 1971), p. 8.

³Maki, Goldman, and Rhame, "Infection Control in Intravenous Therapy," p. 881.

important in prevention of complications (specifically, infiltration). If this is true, a three group study comparing the incidence of infiltration of I.V.'s initiated by professional nurses with specific training and experience in I.V. therapy, technicians who had received special training and experience in I.V. therapy, and staff nurses who administer venipuncture as an additional duty should be warranted. Is the incidence of intravenous infiltration related to the individual's lack of experience and/or special training in I.V. therapy?

Justifications

It was expected that such a study would be significant to the area of prevention of intravenous complications and to the area of controversy about the necessity for intravenous nurse specialists. This study would provide a beginning investigation into one area of prevention of complications (infiltration) of I.V. therapy initiated by the intravenous nurse therapist, technician, or staff nurse measured in terms of patient welfare--the highest criterion of evaluation! It was also believed that further replications and modifications of this study would develop trends that would indicate the course that nursing should take in administration of intravenous fluids.

Purpose of the Study

The purpose of this study was to compare experience of three groups--intravenous nurse therapists, intravenous technicians, and staff nurses--with the incidence of intravenous infiltration during the first eight-hour period after infusions were started.

Hypotheses

The hypotheses tested by this study were:

1. Intravenous infusions initiated by individual staff nurses infiltrate more frequently than those initiated by intravenous nurse therapists and/or intravenous technicians.
2. There is no significant difference in frequency of infiltration of infusions started by intravenous nurse therapists and intravenous technicians.

Assumptions

The following assumptions were believed by the investigator to be inherent in this study.

1. Factors that relate to successful venipuncture must also relate to avoidance of infiltration. "The success of a venipuncture depends on whether its purpose is served. For an infusion, the needle must stay in the vein."¹

¹Janice R. Anderzon, "Emerging Nursing Technique: Venipuncture," Nursing Clinics of North America 3 (March 1968):176.

2. The success of a technique is partially dependent upon the ability of the practitioner to perform that technique.

3. Knowledge of procedural elements of a technique is prerequisite to development and enhancement of skill in that procedure.

4. Skill in a procedure increases with practice.

5. An intravenous team of nurses or technicians will receive more practice in venipuncture than individual staff nurses whose time is absorbed in additional duties.

Definition of Terms

In order to establish a uniform frame of reference for the study, the following definitions were developed.

Intravenous therapy or parenteral infusion--the administration by slow drip of fluids (by force of gravity) into the circulatory system by way of a needle placed in the vein.¹ Continuous intravenous therapy is used to differentiate an infusion from a single injection (via needle and syringe) into a vein.

Infiltration or extravasation--the occurrence of swelling around the needle site after the infusion has been initiated.²

¹Bertha Harmer, Textbook of the Principles and Practices of Nursing, 5th ed., rev. Virginia Henderson (New York: The Macmillan Co., 1960), p. 739.

²Plumer, Principles and Practices of Intravenous Therapy, p. 79.

Intravenous nurse therapist or specialist--a registered nurse who is employed by a hospital for the purpose of performing venipunctures to administer intravenous therapy.¹

Intravenous technician--a person, not a registered nurse, who has received training in administration of intravenous fluids and who is employed by a hospital for the purpose of performing venipunctures to administer intravenous therapy. He works under the direction of a registered nurse. In this study the intravenous technician team was comprised of nine former medical corpsmen and two licensed vocational nurses.

Intravenous team--a group of nurses or technicians who are employed by a hospital for the purpose of performing venipunctures to administer intravenous therapy.

Individual staff nurses--all registered nurses involved in patient care on the various hospital medical-surgical units who, in addition to their other duties, performed intravenous injections on their patients.

Intravenous injection or venipuncture--the insertion of a needle into a vein for the purpose of introducing substances into the blood stream.²

¹Marie Imperiale, "The Intravenous Therapy Nurses," The American Journal of Nursing 61 (May 1961):53.

²John Adriani, "Venipuncture," The American Journal of Nursing 62 (March 1962):66.

Skill--proficiency in the techniques of intravenous injection which contribute to the success of intravenous therapy. Skill, as used in this study, is a product of experience in I.V. therapy.

Experience--the amount of education and training in I.V. therapy and the amount of practice in intravenous techniques.

Scalp vein needle or "butterfly"--a metal needle, approximately three-fourths inch long, attached to a length of light polyethylene tubing with an adapter on the end. There is a plastic flange at the junction of needle and tubing.¹ These butterfly wings fold together to form a fingergrip, permitting more accurate needle manipulation. When released, the wings spread flat against the skin, providing secure anchor surfaces for taping, thus minimizing any chance of needle movement within the vein.²

Site of infusion--the anatomical area used for placement of the infusion needle. The sites of infusions for this study were the anterior or flexor surface of the

¹C. F. P. Wharton, "Infant Scalp Vein Needles in the Intravenous Treatment of Endocarditis in Adults," British Medical Journal 2 (10 June 1967):702.

²Parenteral Administration (Chicago: Abbott Laboratories, 1966), p. 37.

forearm--between the wrist and elbow--and the veins on the dorsal surface of the hand.¹

Limitations

Limitations of the study were recognized by the investigator to evolve from inability to control certain variables.

1. The staff nurses' experience in intravenous therapy varied and it is probable that some were equally proficient in venipuncture as the nurse therapist and/or technician.

2. Time and care in initiating the infusion may have been influenced more by pressures of a busy schedule than the proficiency possessed by the staff nurse starting the infusion.

3. In the hospital where staff nurses did intravenous injections, physicians often performed the more difficult venipunctures.

4. In the hospital where staff nurses did intravenous injections, the units provided for utilization in the study were the ones where most I.V. therapy was performed. Therefore, nurses on these units received more practice than would have a randomly selected group of nurses throughout the hospital.

¹R. J. Last, "Superficial Veins of the Forearm," British Dental Journal 125 (3 December 1968):491.

5. The intravenous technicians and staff nurses often utilized scalp vein needles for patients with long-term continuous I.V. therapy, but the intravenous nurse therapists inserted catheters when continuous infusions were prescribed, thus, intravenous infusions lasting eight hours were less in one hospital than in the other two.

6. Time allowed for the study prevented acquiring a sample large enough to account for influence of such variables as condition of veins, number of previous intravenous injections of the patient, intravenous solutions and drugs used, and activity of the patient.

7. Collection of data was of necessity dependent upon accuracy of reports and recording by a large number of individuals.

A. Because initiation of data collection cards was not a priority with staff nurses, not all injections were reported.

B. The awareness of all three groups of the purpose of the study may have resulted in selective reporting in some cases.

C. Because the extended length of time involved a large group of nursing personnel, that is, floating nurses, and part-time nurses replacing those on vacations or days off, information regarding the study was not made available to all staff nurses.

CHAPTER II

REVIEW OF LITERATURE

Introduction

The investigator found numerous principles of successful technique and many factors thought to be related to the prevention of intravenous infiltration. Two research studies reported the significance of these factors to infiltration.¹ Although skill is recognized to be essential to the execution of successful intravenous therapy, no direct study of skill or expertise for the practitioner was found.

In this study, the literature was reviewed for:

1. The avoidance of infiltration with special emphasis on the needle used (scalp vein) and the site of infusion
2. The importance of experience (skill and knowledge) in intravenous therapy and in infiltration
3. Comparative experience of the intravenous therapist, intravenous technician, and the staff nurse doing intravenous injection

¹Marilyn Sylvester, "A Study to Identify Factors Related to Infiltration in Continuous Intravenous Therapy" (Master's thesis, University of Washington, 1965); and Marjorie Landry, "Factors Related to Infiltration During Continuous Intravenous Therapy" (Master's thesis, Texas Woman's University, 1971).

Avoidance of Infiltration

Plumer thinks that many hazards of intravenous (I.V.) therapy can be avoided if the nurse understands the risks involved and uses all available measures to prevent their occurrence. One such complication is infiltration which is "too frequently considered to be of minor significance."¹ Adverse effects may, however, include pain, edema, phlebitis, and tissue damage.

Infiltration is usually caused by needle dislodgement allowing the infusion fluid to run into the interstitial tissues.² A swelling will appear around the needle, the skin usually blanches, and the infusion will probably slow down and stop as the fluid accumulates outside the vein.³

The infusion must be discontinued immediately because irritating hypertonic, acid and alkaline solutions, and potent drugs may cause necrosis of the tissue.⁴ If

¹Ada L. Plumer, Principles and Practices of Intravenous Therapy (Boston: Little, Brown and Co., 1970), p. 77.

²Barbara P. Levenstein, "Intravenous Therapy: A Nursing Specialty," Nursing Clinics of North America 1 (June 1966):265.

³Elliot V. Newman, "The Technique of Venipuncture and Intravenous Injection," The American Journal of Nursing 52 (April 1952):424.

⁴Plumer, Principles and Practices of Intravenous Therapy, p. 78.

certain vasopressor substances are accidentally injected extravascularly, intense vasoconstriction produces ischemia of the skin blood vessels which may terminate in tissue sloughing, necessitating surgical care and even skin grafting.¹ In addition, leakage of the injected drug from the vein can damage cutaneous nerves.²

If necrosis is avoided, infiltration may nevertheless (1) deprive patients of fluid and drug absorption at rates essential for successful therapy, (2) limit available veins for venipuncture, and (3) predispose patients to infections.³ Vein thrombosis and/or phlebitis may result from repeated venipunctures.⁴ Muir found in a survey of 974 infusions administered to 427 patients, a proportionate increase in phlebitis in those patients subjected to repeated injections. Twelve percent of the patients in the survey received additional injections as a result of intravenous infiltration.⁵

¹Thomas H. Seldon, "Untoward Reactions and Complications During Transfusions and Infusions," Anesthesiology 22 (September 1961):817.

²Ernest Lachman, "Anatomy as Applied to Clinical Medicine," The New Physician 11 (October 1962):363.

³Plumer, Principles and Practices of Intravenous Therapy, p. 78.

⁴Newman, "The Technique of Venipuncture and Intravenous Injection," p. 424.

⁵A. P. Muir, "Intravenous Complications," Applied Therapeutics 6 (December 1964):1005.

Technical aspects of venipuncture have been considered in prevention of infiltration. Fuerst and Wolff list scientific principles for the procedure as follows: (1) the antecubital veins should be avoided if possible because arm motion will move the vein, causing a change in position of the needle; (2) insertion of the needle at a 45° angle will prevent direct pressure which may put the needle through the opposite wall of the vein; (3) following the course of the vein and placing the needle well into the vein will help prevent dislodgement; and (4) securing the needle and limiting the movement of the arm are other measures suggested for prevention of infiltration.¹

The factors associated with successful intravenous therapy studied by Sylvester and Bruno included needle gauge; length of the needle; method of taping the needle; site of infusion; use of arm board; condition of veins; age, sex, and activity level of the patient; length of time of infusion; number of infusions; time of infiltration; and nursing hours during the period of infusion.² A total of 103 infusions were studied of which twenty-one infiltrated. They found only three variables to be significantly related

¹Elinor V. Fuerst and Luverne Wolff, Fundamentals of Nursing, 3d ed. (Philadelphia: J. B. Lippincott Co., 1964), p. 350.

²Marilyn Sylvester and Pauline M. Bruno, "Factors Associated with Infiltration During Continuous Intravenous Therapy," Nursing Research 15 (Summer 1966):255.

to infiltration: infusions infiltrated more frequently when shorter needles were used, when the patient was more active, and when non-professional nursing hours were above the mean.¹

Landry modified Sylvester's study and did an extensive review of the literature in regard to some of these factors. She reported that the forearm and back of hand are the preferred sites of infusion for prevention of complications and that the aging process of veins may contribute to infiltration. She surveyed 330 venipunctures of 170 patients for needle type, infusion site, method of taping the needle, age and sex of the patient, and upper extremity utilized for the infusion in relation to the handedness of the patient. Seventy--41.1 percent--patients experienced infiltration. None of the factors studied proved to be significant to infiltration. However, she did note two trends: (1) there was an indication that infiltration was more frequently associated with infusions started with a

¹"The nature of the relationship between nursing hours and infiltration gave rise to certain questions. Perhaps the relationship between nursing hours and infiltration was associated with the degree of illness of the patient and the number of infusions administered during a given period of time. It was demonstrated that infusions infiltrated less often when patients were relatively inactive. Were nursing hours related to patient activity: That is, when less nursing time was available, were nurses less likely to encourage and contribute to patient activity?" (Sylvester and Bruno, "Factors Associated with Infiltration," p. 256.)

scalp vein needle than infusions started with a one-inch needle; and (2) patients above 49.7 years of age experienced more infiltrations than did the younger patients.¹

Infusion site

Recommendations for vein selection include choosing a vein that can be easily seen and palpated, one large enough to accommodate the needle used, and located in an area in which the surrounding tissue provides support.² Clark, Jolly, and Anderzon advocate the use of veins in the forearm for intravenous infusions, because the criteria for vein selection in most instances would be met using this site.³ "The veins are supported by subcutaneous tissue, and the bones in the forearm offer a natural splint so that the arm rarely needs to be immobilized," providing greater comfort for the patient.⁴ "Venipuncture in a forearm vein

¹Landry, "Factors Related to Infiltration During Continuous Intravenous Therapy," p. 53.

²Newman, "The Technique of Venipuncture and Intravenous Injection," p. 419; Janice B. Anderzon, "Emerging Nursing Technique: Venipuncture," Nursing Clinics of North America 3 (March 1968):172; and Joan Haselman, "Teaching Principles of Intravenous Therapy," The Journal of Nursing Education 2 (September 1963):37.

³Richard B. Clark, "The Art of Venipuncture," The New Physician 13 (August 1964):253; Clive Jolly, "Intravenous Technique," The Practitioner 184 (January 1960): 85; and Anderzon, "Emerging Nursing Technique: Venipuncture," p. 172.

⁴Anderzon, "Emerging Nursing Technique: Venipuncture," p. 172.

and securing of the needle and tubing allow the patient some movement without the risk of piercing the posterior wall of the vein."¹ Levenstein agrees that, when therapy is not to be of long duration, it is best to place the needle in a vein between wrist and elbow joints on the lateral aspect of the forearm to allow natural motion without risk of infiltration.² While most superficial veins are suitable for venipuncture, the median cephalic vein is most often recommended because of its easy accessibility, its relative immobility, and its low incidence of thrombophlebitis. Anatomically, damage to nerves by venipuncture is not a great danger when this vein is utilized.³ Fig. 1 and Fig. 2 show veins of the forearm and hand which may be utilized as venipuncture sites for initiating intravenous therapy.

Generally, the two most preferred sites for venipuncture are the lower forearm and the back of the hand.⁴ Last states that the dorsum of the hand and the flexor surface of the forearm provide a choice of veins suitable for

¹Parenteral Administration (Chicago: Abbott Laboratories, 1966), p. 7.

²Levenstein, "Intravenous Therapy: A Nursing Specialty," p. 263.

³R. J. Last, "Superficial Veins of the Forearm," British Dental Journal 125 (3 December 1968):494.

⁴"I.V. Sets: Product Survey," Nursing 72 2 (October 1972):34.

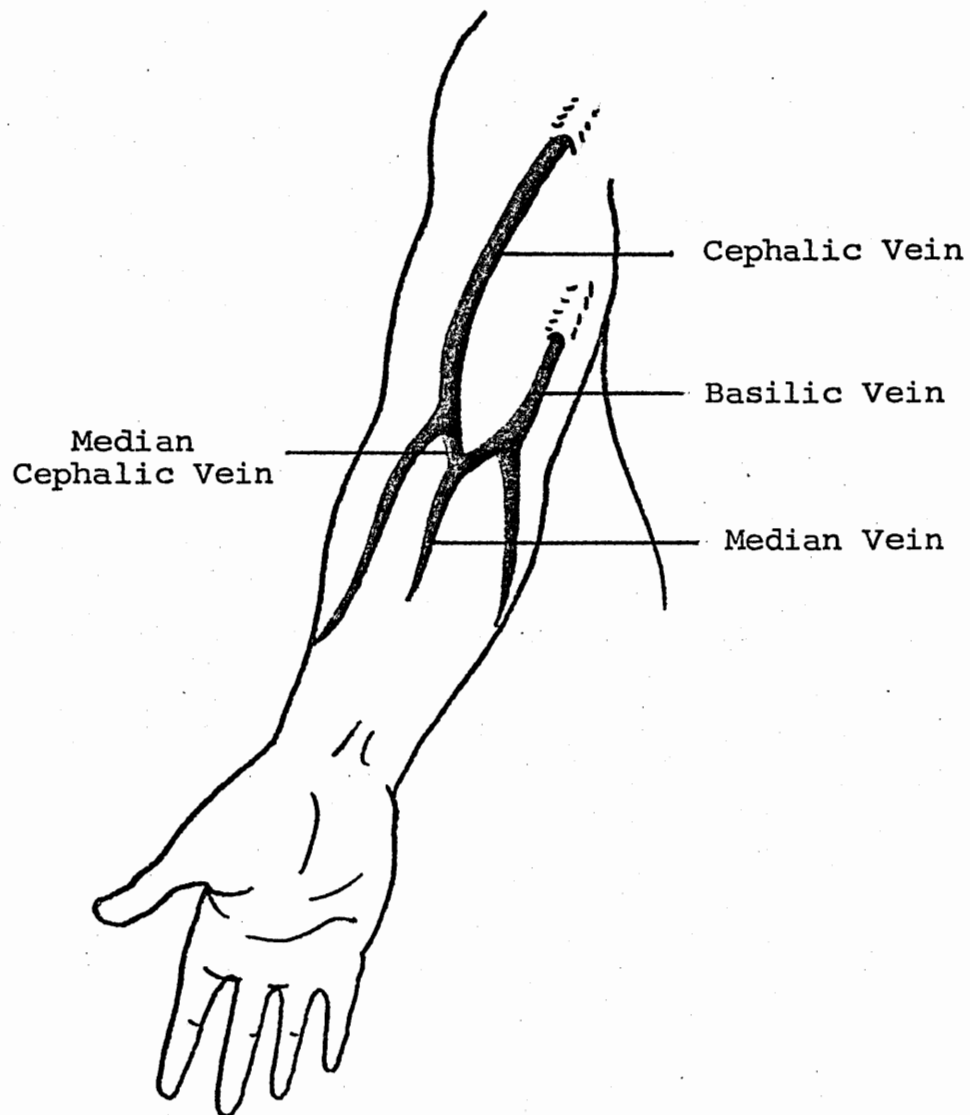


Fig. 1. Large veins of forearm frequently utilized as venipuncture sites for initiating intravenous therapy.

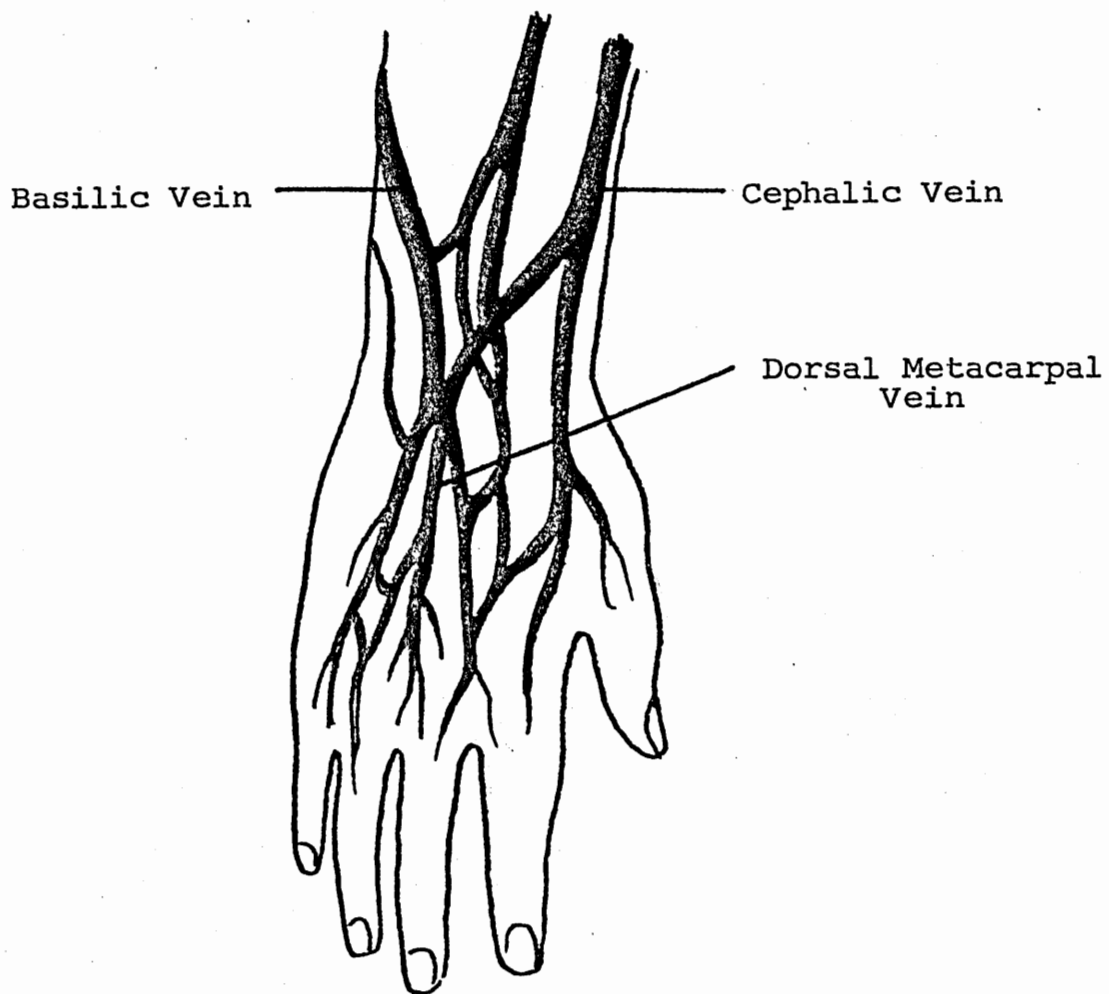


Fig. 2. Veins of the dorsum of the hand which may be used as venipuncture sites for initiating intravenous therapy.

entry.¹ Clark also recommends the back of the hand, but admits these veins may be fragile in older patients.² Adriani and Anderzon are extensive in their criticism of this site for venipuncture. The disadvantages they list include the following: (1) the veins tend to slide and roll, (2) when tension is applied after entry, they tend to collapse, (3) it is difficult to anchor the needle, (4) veins are small and do not accommodate a large needle, nor can a needle be threaded into the lumen to hold them securely for long-term therapy, (5) veins are sclerosed in the elderly, (6) these veins are first to collapse when the blood pressure falls in shock, and (7) there is not enough blood present to act as a diluent for irritating drugs or solutions. An additional disadvantage is that when a needle is withdrawn from one of these veins, leakage of blood tends to occur because of loosening of the skin over the site.³ Jolly states, however, that "a well-chosen vein and carefully-fastened needle in this position will last as long as in most other places."⁴ Plumer points out that frequently the

¹Last, "Superficial Veins of the Forearm," p. 491.

²Clark, "The Art of Venipuncture," p. 253.

³John Adriani, "Venipuncture," The American Journal of Nursing 62 (March 1962):67; and Anderzon, "Emerging Nursing Technique: Venipuncture," p. 171.

⁴Jolly, "Intravenous Technique," p. 85.

dorsal metacarpal veins (back of hand) furnish points of entry to be utilized first to preserve more proximal veins for further therapy--"the use of these veins depends upon their condition."¹

Antecubital veins are poor choices for infusion because of likelihood of infiltration in flexing the arm and because of the chance of intra-arterial injection. The artery may be aberrant and lie superficial to the vein. An additional danger may be a tear in the wall of the vein with extravasation of blood or sclerosis of the vein resulting from reaction to injected medication, which may render all veins distal to that area of no value for future use.² Jolly warns against the use of a vein over the elbow or wrist joint as the needle will have to remain in place for a long period of time and movement may dislodge it and damage the vein wall. "If splinting is effective enough to prevent joint movements, then the bandaging will probably interfere with the venous return."³

Neither Sylvester and Bruno nor Landry found infusion site to be statistically significant to

¹Plumer, Principles and Practices of Intravenous Therapy, p. 42.

²Jon T. Williams and Daniel F. Maravec, "Intravenous Therapy: Procedures and Techniques," Hospital Management 101 (March 1966):63.

³Jolly, "Intravenous Technique," p. 85.

infiltration. Sylvester and Bruno did, however, note a trend which suggested that infusions infiltrated more often when the hand or antecubital fossa was the site of infusion.¹ Conversely, Landry found that the incidence of infiltration increased when the veins of the forearm were utilized.²

Needle (scalp vein needle)

Most authors recommend eighteen, twenty, or twenty-two gauge needles that are one and one-half to two inches long and have a medium size bevel. Length of the needle is related to the frequent recommendation for threading the needle one-half to three-fourths inch into the lumen of the vein.³ Moderate-sized needles rather than small needles are less likely to become obstructed and they offer less resistance to the flow of fluid.⁴

Sylvester and Bruno used needles that were either one inch or one and one-half inches in length. Of the eighty-three infusions started with a one-inch needle,

¹Sylvester and Bruno, "Factors Associated with Infiltration During Continuous Intravenous Therapy," p. 257.

²Landry, "Factors Related to Infiltration During Continuous Intravenous Therapy," p. 35.

³Adriani, "Venipuncture," p. 69; Fuerst and Wolff, Fundamentals of Nursing, p. 346; and Anderzon, "Emerging Nursing Technique: Venipuncture," p. 175.

⁴Newman, "The Technique of Venipuncture and Intravenous Injection," p. 424.

twenty-one infiltrated and sixty-two did not. The remaining twenty infusions were started with a one and one-half inch needle and none of those infiltrated. They concluded that one-inch needles were significantly related to infiltration.¹ Landry found that infusions started with scalp vein needles infiltrated more frequently than infusions using one-inch needles.² Fifty percent of Muir's patients who received initial injections via a straight or scalp vein needle--as opposed to a catheter--had to receive a second injection due to the intravenous running interstitial.³

The literature, however, has increasingly reported favorable aspects of the scalp vein needle. Even when they were still being used predominately for infants, Clark stated, "It is surprising how long a scalp vein needle will stay in an infant when just the point is in the vein."⁴ Jones called it "an excellent piece of apparatus which greatly facilitates entry."⁵ Wharton lists advantages in the use of scalp vein needles for venipuncture:

¹Sylvester and Bruno, "Factors Associated with Infiltration During Continuous Intravenous Therapy," p. 256.

²Landry, "Factors Related to Infiltration During Continuous Intravenous Therapy," p. 53.

³Muir, "Intravenous Complications," p. 1005.

⁴Clark, "The Art of Venipuncture," p. 255.

⁵Peter F. Jones, "Intravenous Infusion Techniques," Proceedings of Royal Society of Medicine 60 (January 1967): 73.

- (1) Adequate venepuncture is always easy and relatively painless; . . .
- (2) There is a large number of suitable small peripheral veins.
- (3) Infective and thrombotic complications are less likely and less serious at peripheral sites.
- (4) Venous trauma is minimal with the gauge of needle.
- (5) When the patient's condition allows, he is able to enjoy full mobility in the ward.
- (6) The needle may be removed at night to be replaced the next morning, . . . allowing undisturbed sleep, . . . a very suitable method of intermittent intravenous therapy.¹

The scalp vein needle is reported to facilitate venipuncture even in infants or elderly persons with fragile, rolling veins. The short bevel decreases the possibility of accidental puncture of the posterior wall of the vein.

"Siliconed thinwall construction permits use of smaller outside needle diameter, without sacrificing flow capacity. A 'thinwall' needle has an inside diameter one size larger than its gauge."² Because of needle standardization and its near-exclusive small-vein application, the scalp vein needle is relatively trouble-free in the site-selection process--even though the general site area has been used a number of times.³ This type of needle is a multi-faceted intravenous tool with a range of utility running from the "simple

¹C. F. P. Wharton, "Infant Scalp Vein Needles in the Intravenous Treatment of Endocarditis in Adults," British Medical Journal 2 (10 June 1967):702.

²Parenteral Administration, pp. 37, 13.

³"I.V. Sets: Product Survey," p. 34.

blood transfusion to the more complex anesthetic administration."¹

The scalp vein needle, however, is not immune to complications. Lowenbraun et al. report a study in which twenty-four out of seventy-four scalp vein needles cultured positive for microorganisms.² Crenshaw et al. cultured scalp vein needles after discontinuance of infusions in 100 patients. Nineteen needles were positive for bacterial growth. They found that the incidence of positive cultures and the development of inflammatory changes at the needle were both related to length of the infusion. In their study, twenty infusions had to be discontinued because of infiltration, but no infusion lasted less than eighteen hours.³

Harbin and Schaffner reported three episodes of bacteremia associated with the use of scalp vein needles over a period of two and one-half years. They estimate that the risk of complicating bacteremia may be seventy-five times greater for intravenous catheters than for scalp vein needles, and conclude that the use of scalp vein needles is

¹Ibid., p. 29.

²S. Lowenbraun et al., "Infection from Intravenous 'Scalp-Vein' Needles in a Susceptible Population," Journal of American Medical Association 212 (20 April 1970):451-53.

³Charles A. Crenshaw et al., "Prevention of Infection at Scalp Vein Site of Needle Insertion during Intravenous Therapy," American Journal of Surgery 124 (July 1972):43-45.

a more acceptable means of parenteral administration of fluids.¹

Crossley and Matsen state that the scalp vein needle is seemingly much less apt to infiltrate than a conventional needle and provides a reliable channel for parenteral therapy. Their prospective study was comprised of 219 scalp vein needle insertions in 142 patients. The needles were in place one to seventeen days in either hand, forearm, or scalp in infants. Pathogenic organisms were recovered from 4.2 percent of the needle tips. "The low morbidity associated with the scalp vein needle suggests that except in carefully selected cases it ought to be the route of choice for parenteral therapy."² The Center for Disease Control in Atlanta supports the use of the scalp vein needle as a preferable alternative to the plastic catheter in most clinical circumstances.³

Importance of Skill and Knowledge

According to Levenstein, venipuncture, which at first appears to be the simple act of injecting a needle,

¹Robert L. Harbin and William Schaffner, "Septicemia Associated with Scalp Vein Needles," Southern Medical Journal 66 (June 1973):638.

²Kent Crossley and John M. Matsen, "The Scalp Vein Needle: A Prospective Study of Complication," Journal of American Medical Association 220 (15 May 1972):987.

³Dennis G. Maki, Donald A. Goldman, and Frank S. Rhame, "Infection Control in Intravenous Therapy," Annals of Internal Medicine 79 (December 1973):871.

requires a good deal more of the practitioner when all factors are considered.¹ "Venipuncture is not without its hazards and the doctor, nurse, or technician charged with the responsibility of intravenous therapy needs both knowledge and special skills."² Throughout the procedure, injury to veins and surrounding tissues must be carefully avoided in order to assure no interference with subsequent intravenous therapy. Multiple punctures due to inexperience will cause trauma which results in swelling, pain, tenderness, and thrombosis.³ "Only minimum trauma results from a venipuncture skillfully executed, whereas carelessly performed venipuncture may seriously traumatize the venous wall."⁴

Repeated traumatic efforts to get needles into veins provide opportunities for introduction of skin contaminants. Poor techniques used in the insertion of steel needles, plastic needles, or plastic catheters frequently result in local thrombophlebitis and cellulitis.⁵ "The skill of the

¹Levenstein, "Intravenous Therapy: A Nursing Specialty," p. 267.

²Adriani, "Venipuncture," p. 70.

³Ibid.

⁴Plumer, Principles and Practices of Intravenous Therapy, p. 76.

⁵Seldon, "Untoward Reactions and Complications during Transfusions and Infusions," p. 817.

operator . . . bears on the incidence of thrombophlebitis. The danger increases when mishandling causes local trauma and venous spasm."¹ Muir found a proportionate increase in phlebitis when a patient received repeated injections and recommended that a study be devoted to improvement of techniques in order to eliminate the large number of infiltrations.²

Prevention of local complications relies upon the application of careful techniques as well as avoiding the use of potentially dangerous agents or solutions.³ All intravenous infusions result in venous irritation, but "severity depends upon the medicine given, the type of needle used, the number of times the site is injected, and the length of time the needle is left in the vein."⁴

Those states that have sanctioned nurses to do venipuncture have clearly stated that the nurse must be instructed in the technique and must demonstrate competency in supervised practice before she is qualified to administer intravenous therapy. If the state and institution in which

¹Nancy E. Johnson, "Coping with Complications of Intravenous Therapy," Nursing 72 2 (February 1972):6.

²Muir, "Intravenous Complications," p. 1007.

³Seldon, "Untoward Reactions and Complications during Transfusions and Infusions," p. 818.

⁴Indications for I.V. Therapy (Chicago: Abbott Laboratories, 1968), p. 25.

the nurse practices recognizes venipuncture as a function of the professional nurse, she must be responsible for obtaining adequate instruction and practice in the technique before attempting to do the procedure on a patient.¹ It is Anderzon's opinion that many hours of practice are needed before one feels confident in performing a venipuncture. "Success is contingent upon the triad of skill, knowledge and a sensitivity to the patient who is to receive the venipuncture."²

Haselman believes that "no procedure in the armamentarium of modern medicine requires more precise understanding by the nurse if it is to produce a maximum benefit to the patient with a minimum of discomfort."³ A correlated knowledge of anatomy, microbiology, pharmacology, medicine, and surgery is necessary for successful execution of intravenous therapy.⁴ Adequate understanding of the principles and techniques requires thorough knowledge of various major scientific areas including:

¹Anderzon, "Emerging Nursing Technique: Venipuncture," p. 166.

²Ibid., p. 177.

³Haselman, "Teaching Principles of Intravenous Therapy," p. 21.

⁴Levenstein, "Intravenous Therapy: A Nursing Specialty," p. 267.

. . . 1) the physical principles underlying intravenous therapy, 2) the physiologic principles involved, 3) the indications for intravenous therapy, 4) the attitudes and skills essential to such therapy, and 5) the possible adverse effects fluid therapy can produce and the correctional measures that must be instituted when untoward effects occur.¹

Harmer and Sutton state more specific requirements. They stress that the nurse be knowledgeable regarding location and suitability of vessels for intravenous therapy; anatomy to avoid injuring glands, bones, and nerves; chemical composition, actions and adverse reactions of substances used in intravenous therapy; and last, but not least, they stress the importance of the nurse being skilled in this procedure.²

Plumer and Shanck agree that the execution of safe successful fluid therapy is largely dependent upon skillful nursing care. The nurse responsible for intravenous therapy must keep abreast of current literature on fluid and electrolyte balances in addition to the new medications and possible reactions to them.³ "She cannot conscientiously administer

¹Haselman, "Teaching Principles of Intravenous Therapy," p. 21.

²Bertha Harmer, Textbook of the Principles and Practices of Nursing, 5th ed., rev. Virginia Henderson (New York: The Macmillan Co., 1960), p. 740; and Audrey Latska Sutton, Bedside Nursing Techniques in Medicine and Surgery (Philadelphia: W. B. Saunders Co., 1964), pp. 67-68.

³Plumer, Principles and Practices of Intravenous Therapy, p. 59; and Ann H. Shanck, "The Nurse in an Intravenous Therapy Program," The American Journal of Nursing 57 (August 1957):1013.

any fluid or medication to a patient without being aware of the dangers as well as the benefits of the therapy for which she is indirectly responsible."¹

The importance of self-confidence of the nurse doing intravenous injection is stressed. She should be secure in her understanding of: (1) why the intravenous procedure is being done; and (2) the techniques involved. Apprehension of the patient may be allayed by a calm, efficient, and confident manner. The best way to gain confidence and improve skill is through repeated performance. "Preparedness is the key to the skills involved in intravenous therapy."²

Comparable Experience of the Three Groups
(Preparation and Practice)

For purposes of this study, the literature was reviewed to compare experience (preparation and practice) in I.V. therapy of three groups--intravenous nurse therapists, intravenous technicians, and staff nurses who also administer intravenous injections. The preparation and practice of each group will be discussed. Special education that intravenous nurse therapists receive can be found described

¹Shanck, "The Nurse in an Intravenous Therapy Program," p. 1013.

²Haselman, "Teaching Principles of Intravenous Therapy," p. 36; and Anderzon, "Emerging Nursing Technique: Venipuncture," p. 169.

in the literature; however, very little can be found regarding any specific intravenous instruction received by technicians and staff nurses who do intravenous injections. The arguments that have been cited for special in-depth knowledge in intravenous therapy would seem to indicate a disparaging view of the function of the technician. Admittedly, his knowledge is probably less comprehensive than that of the registered nurse, but his developed skill may warrant use of an intravenous team of technicians. As technicians do not administer medications, the staff nurse caring for the patient is still responsible for supervision of I.V. therapy. The debate for or against an intravenous team then revolves around the question of whether administration of intravenous fluid is a specialty in I.V. therapy or a specialized skill in intravenous technique.

The intravenous nurse therapist

Special training courses for intravenous nurses are recorded as lasting from several weeks to three months. Teams may be organized under pharmacy, laboratory, or nursing service. Instruction encompasses a review of anatomy, including the venous system and related structures, training in technique, and readings concerning complications of I.V. therapy.¹ A pathologist, anesthesiologist, or qualified nurse usually supervises instruction and practice in

¹Levenstein, "Intravenous Therapy: A Nursing Specialty," p. 260.

venipuncture. The nurse practices under supervision until her knowledge and skills satisfy the department head.

Richardson's program provided a highly trained technician from a drug company to assist the nurses in their venipuncture procedures and to acquaint them with various solutions available. Richardson reported that replacements for resigned team members were closely supervised for three months before they were permitted to administer fluids on the ward units by themselves. Even longer time was spent in teaching nurses to administer blood transfusions.¹

Intravenous teams usually have specific written guidelines of policies and procedures.² Paoloni reported guidelines which included qualifications, functions and duties, rate of flow, recommended sites for venipunctures, maximum number of unsuccessful venipuncture attempts, infiltration, preparation of site, needle for venipuncture, and orders for standard operating procedures.³

The intravenous nurse therapist whose sole function is to administer intravenous fluid is sure to gain more

¹John B. Richardson, "Intravenous Therapy Teams: A New Nursing Service," Hospitals Journal of American Hospital Association 36 (16 August 1962):84-85.

²Janet Spoon, "The I.V. Team in the Pharmacy," Supervisor Nurse 4 (November 1973):50-59.

³Claude U. Paoloni, "Procedures for Handling Intravenous Additives: The Nursing Team Approach," Hospital Management 108 (September 1969):22.

experience in this area than a nurse who performs various additional duties during her working day. "Since venipunctures are a part of her daily routine, the intravenous nurse has plenty of opportunity for the practice necessary to become highly skilled."¹ Levenstein agrees that the skills of the therapist will be sharpened with practice and Jolly points out that "only practice will make more perfect."²

Not only do team members become specialists in intravenous technique, they become highly efficient and knowledgeable regarding the special properties of infusion solutions and drugs. Intravenous nurses are usually authorized to start injections for all fluids, for blood and blood derivatives, and add prescribed drugs or other additives to the intravenous bottle.³ Spoon found that having a team responsible for changing intravenous sets and filters provided a sure systematic way of getting them changed daily.⁴

Levenstein believes that a group of specially trained nurses maintains a control for patient safety

¹Spoon, "The I.V. Team in the Pharmacy," p. 49.

²Levenstein, "Intravenous Therapy: A Nursing Specialty," p. 259; and Jolly, "Intravenous Technique," p. 84.

³Eleanor E. Durr and Louis E. Fierro, "I.V. Therapy as a Nursing Responsibility," RN 33 (September 1970):38.

⁴Spoon, "The I.V. Team in the Pharmacy," p. 53.

against indiscriminate practices.¹ The possibility of error is reduced. Infusions are begun promptly and patients receive closer observation and better care. An intravenous nurse has time to stay with a patient during the first crucial fifteen minutes of a blood transfusion.²

Richardson states that an intravenous team will help to conserve and protect the patient's veins.³ The patient may also benefit from the expertise of the intravenous nurse, because she is aware of drug incompatibilities, and she has the time to double check physicians' orders and calculate flow rates.⁴ The nurse therapist is a skilled observer who has the time and knowledge to use proper technique, explain procedures, and judge the patient's reaction.⁵

Isler, in her case for the intravenous nurse therapist, remarks that as I.V. therapy mushroomed and became increasingly more complex and important, "I.V. nurses widened their skills . . . and have emerged as true specialists."⁶ Having nurses especially skilled in starting and maintaining

¹Levenstein, "Intravenous Therapy: A Nursing Specialty," p. 259.

²Johnson, "Coping with Complications of Intravenous Therapy," p. 8.

³Richardson, "Intravenous Therapy Team: A New Nursing Service," p. 84.

⁴Spoon, "The I.V. Team in the Pharmacy," p. 49.

⁵Charlotte Isler, "I.V. Therapy: The Hidden Dangers," RN 36 (October 1973):27.

⁶Ibid., p. 26.

I.V. therapy in critically and terminally ill patients adds up to better patient care.¹ This same article quotes the support of the U.S. Center for Disease Control in Atlanta:

A review of the literature indicates that proper maintenance of intravenous fluid systems is most efficiently and effectively carried out if intravenous 'Teams' are responsible for intravenous therapy throughout the hospital. Heterogenous groups of individuals, such as house officers, staff doctors, and nurses have been much less successful in methodically and meticulously following the above recommendations.²

The intravenous technician team

Intravenous teams of technicians came into existence before nurses were utilized for intravenous injection.³ The administration of intravenous fluids was previously viewed as a technical operation to be performed by physicians or specially trained technicians.⁴ That view is now being challenged by many who consider I.V. therapy a specialty requiring highly knowledgeable nurses. Certain advantages of the intravenous nurse therapist team, however, apply equally well if a team is composed of highly skilled and responsible technicians. Spoon thinks that the most obvious reason for the choice of nurses to do venipunctures is that of professional judgment.

¹Ibid., p. 26. ²Ibid., p. 27.

³Sutton, Bedside Nursing Techniques in Medicine and Surgery, p. 67.

⁴Harmer, Textbook of the Principles and Practices of Nursing, p. 739.

Although doing venipuncture is a technical job, there is always a need to observe the patient and make decisions about the best method to use. There always exists the possibility of adverse reactions and an R.N. has the training and background to recognize them and institute the proper treatment.¹

Is there a place for the intravenous technician in today's health maintenance? Licensed vocational nurses' (LVN) educational processes do not as a rule include intravenous therapy. Some hospitals, however, have initiated training programs to prepare the LVN in giving intravenous injections. Should all hospitals utilize ex-medical corpsmen and licensed vocational nurses to perform this highly technical specialized service as the enterprising hospital in this study has done? It is well known that the need for paramedical personnel and their proper utilization is of paramount importance in this time of hospital staff shortage.² According to Zentmyer, the continuing expansion of the frontiers of medical technology requires trained technicians to operate ever more complex equipment and to act as linking pins between the medical profession and the body of technology. He reports that military organizations have utilized paramedical allied health personnel with a high degree of success for many years. "The army and air force

¹Spoon, "The I.V. Team in the Pharmacy," p. 59.

²Arthur E. Cocco and Florence M. Gipe, "The Utilization of Trained Military Personnel in the Baltimore Hospital Area," Maryland State Medical Journal 16 (December 1967):59.

medics and the navy hospital corpsmen certainly need no selling job to the general public--their records of service and professionalism stand virtually unchallenged."¹

In 1971, it was reported that between 30,000 and 35,000 medically trained and experienced health personnel were leaving the armed forces each year. Of this number, only 12.5 percent were being employed in civilian health occupations. A higher percentage was found, however, for men whose medical duties required ten or more weeks of military training.² In a survey of twenty-one hospitals, returned questionnaires from eighteen hospitals reported that during the past they had employed at some time or another personnel who were trained in the army. All but one expressed the opinion that military-trained personnel were superior in every aspect. "In most instances, ex-military personnel were assigned work of higher quality and responsibility and that his [*sic*] performance of such skills and techniques were usually of a higher quality than that of non-military personnel."³

¹Robert K. Zentmyer, "Training of Allied Health Personnel: A Practical Approach," Clinical Obstetrics and Gynecology 15 (June 1972):333.

²Joel Kramer, "Military Trainees: A Pool of Medical Talent," Science 169 (4 September 1970):957.

³Cocco and Gipe, "The Utilization of Trained Military Personnel in the Baltimore Hospital Area," p. 60.

In screening returning corpsmen for civilian jobs, one would have to evaluate previous experience according to training and service since there are at least three different levels of training and experience provided by the different branches of the service. The objectives of army corpsmen education are to train enlisted personnel in basic and advanced techniques and procedures of field medicine and surgery, in principles of preventive medicine and field sanitation, and in dispensary and sick call procedures.¹ Goldstein reported in 1970 that this intensive training is completed in eight weeks during wartime or twelve weeks during peacetime. "Experientially the medical corpsmen may perform highly complex tasks in the combat setting; however, the training time designated is relatively brief considering tasks and skills to be learned."²

Zentmyer describes the armed forces type of training as a utilitarian approach--based upon technical performance skills--which prepares students for health care occupations quickly, efficiently, and adequately. "Training is usually defined as an increase of knowledge and skill in doing a particular job."³ He points out that civilian educators are

¹Joan Goldstein, "Medical Corpsmen as a Source of Civilian Health Manpower for New Jersey," Medical Care 8 (May-June 1970):255.

²Ibid.

³Zentmyer, "Training of Allied Health Personnel: A Practical Approach," p. 334.

frequently surprised at the rapidity in which these short courses develop such a high degree of skill in the young military technician--"skill which is clearly demonstrated by the high level of performance and responsibility which these men demonstrate."¹

The successful use of this [practical] approach [to training] also belies the traditional tendency to equate greater productivity and higher quality performance with educational achievement--a tendency identified by many authorities as one of the major problems in overcoming health manpower shortages.²

In Goldstein's opinion, training and field experience for all branches of the service seem to prepare a corpsman for the emergency room, ambulance service, and the operating room. "In the past several years, a number of paraprofessional programs have been developed for the training of manpower who may perform similar functions to those that the nurse or physician may have performed in the past."³

Bergen states that "leaders in the medical field increasingly recognize that many of the duties performed by physicians are routine and repetitive, and can be performed by non-physicians after proper training and under supervision."⁴ But he cautions, however, that although many of

¹Ibid., p. 334. ²Ibid., p. 335.

³Goldstein, "Medical Corpsmen as a Source of Civilian Health Manpower for New Jersey," p. 256.

⁴Richard P. Bergen, "Liability for use of Paramedical Personnel," Connecticut Medicine 35 (February 1971): 78.

these duties may be routine and technical, they may be crucial to the well-being, health, and life of a patient. For this reason, the delegation of duties of such personnel must be carefully selected. "The important factor obviously is the safety and well-being of the patient."¹

In summation, Goldstein concludes:

What we would hope to gain is a new member of the health care team who could perform services previously assigned to the physician. . . . Precisely what these tasks and skills are--that most certainly is the question.²
(Italics mine.)

The staff nurse

The amount and type of intravenous instruction that a student nurse receives varies with the school she attends, the instructors that she has, and the philosophy of nursing education at the time she receives her education. Nursing texts, for the most part, give implicit directions in technique and describe responsibilities involved in intravenous therapy. They indicate, however, that the nurse's responsibilities in I.V. therapy will be determined by the individual agency in which she works.³ Thompson suggests that one

¹Ibid.

²Goldstein, "Medical Corpsmen as a Source of Civilian Health Manpower for New Jersey," p. 259.

³Fuerst and Wolff, Fundamentals of Nursing, p. 347; and Ella L. Rothweiler and Jean M. White, The Art and Science of Nursing, 6th ed., rev. Doris Geitgey (Philadelphia: F. A. Davis Co., 1959), p. 343.

consider the nurse's preparation in performing the procedures as well as her knowledge of cause and effect. "Often the teaching has been . . . a hit-or-miss affair--consisting, perhaps, of nothing more than a demonstration without even one supervised practice."¹

It was Terenzio's opinion that all graduate nurses could be trained to do a good job; that is, they should possess the judgment and skill necessary to do venipuncture and give intravenous infusions.² Anderzon thinks that instruction should be provided by the institution that allows nurses to do venipunctures. "Pathologists, anesthesiologists, and nurses in charge of the intravenous therapy teams that function in some hospitals frequently teach the techniques involved."³ Sutton expressed the opinion that the majority of nurses, who are required to perform this treatment, too often and sometimes too eagerly carry out this procedure which is entirely new to them, with little knowledge concerning the principles, techniques, or complications involved--placing the patient in jeopardy.⁴

¹Nadine Thompson, "Nurses and Venipuncture," Nursing Outlook 3 (July 1955):393.

²Peter B. Terenzio, "Should Nurses Do Venipuncture?" The American Journal of Nursing 51 (October 1951):604.

³Anderzon, "Emerging Nursing Techniques: Venipuncture," p. 166.

⁴Sutton, Bedside Nursing Techniques in Medicine and Surgery, p. 67.

The investigator was able to find only one description of a specialized program to teach staff nurses to initiate intravenous infusions. The particular institution decided to teach all of their nurses to do venipuncture. The program was approximately seven weeks in length, in which nurses were taught legal aspects, principles and procedures, electrolyte and acid-base balance, and drugs and solutions. A period of supervised practice followed observation and instruction in the techniques.¹ It is recognized that most hospitals have written procedures for I.V. therapy and some may include variable amounts of instruction in some type of inservice education program.

In determining whether nurses can efficiently and skillfully do venipunctures along with other patient care, the important issues to be considered are patient welfare and nursing time. Bergin decided against an intravenous nurse team because "we wanted to keep our nurses in nursing."² "To limit well-educated R.N.s to the performance of a single task would not encourage professional growth, nor did it seem like the most effective way of utilizing our limited nursing power."³ Harmer agreed, "Until there are enough nurses

¹Margaret A. Bergin, "All our Nurses Give I.V.'s!" RN 23 (November 1965):50.

²Ibid., p. 47. ³Ibid.

to give nursing care it is wasteful of nursing potential to convert nurses into medical technicians."¹

Bergin argued that patients should have the security of having the same nurses ministering to them who gave them daily care. She pointed out that the intravenous therapist is usually not familiar with the patient's complete history.² In addition, some staff nurses enjoy starting infusions, are very good at it, and may not want to give up their intravenous functions. "It's part of the total patient care and the staff nurse is trying every day to provide just that."³ It is said that the nurse will spend more time at the bedside if she has the responsibility for I.V. therapy.

However, a successful venipuncture requires time. Assuring safe correct fluid therapy involves time. Newman indicates that the most frequent cause of failure to accomplish an intravenous infusion is lack of care and time in selecting the most suitable vein which is available.⁴ Does the staff nurse have adequate time for skillful execution of intravenous injections? Spoon describes the dilemma: "The staff nurse has countless things to do, innumerable items

¹Harmer, Textbook of the Principles and Practices of Nursing, p. 740.

²Bergin, "All our Nurses Give I.V.'s!" p. 47.

³Spoon, "The I.V. Team in the Pharmacy," p. 57.

⁴Newman, "The Technique of Venipuncture and Intravenous Injection," p. 418.

to remember and she is always being interrupted in her work."¹ Because of lack of time, she may not be as careful as she knows she should be. "Since skill in doing venipunctures is largely a matter of practice, nurses who only occasionally start an I.V. find themselves at a definite disadvantage."²

Perhaps it is relevant to ask with Mitchell:

Has the nursing profession been short-sighted in allowing itself to accept certain tasks without first analyzing the staffing requirements which will be necessary for these tasks to be carried out as they ought to be, while still giving a high standard of nursing care to the individual patient?³

¹Spoon, "The I.V. Team in the Pharmacy," p. 48.

²Ibid.

³Evelyn Mitchell, "Much Ado About Something," Nursing Times 68 (March 1972):368.

CHAPTER III

METHODOLOGY

Type of Study

A non-experimental exploratory survey was conducted to compare the incidence of infiltration of intravenous infusions initiated by a group of intravenous technicians, a group of intravenous nurse therapists, and a group of staff nurses. The study was done to determine if preparation and practice of the group doing venipuncture were related to incidence of infiltration. It was assumed that skill of the practitioner is dependent upon the amount and type of preparation and practice he or she receives and that infiltration, in many cases, can be attributed to lack of skill and knowledge in intravenous therapy.

Setting

The study was conducted in three large general hospitals located in a metropolitan area of approximately two million people. The hospital (Hospital A) which operated with an intravenous team of technicians was a 680 bed, non-profit, teaching, research-oriented hospital. The team was composed of nine former medical corpsmen and two licensed vocational nurses under the supervision of a registered nurse. The department was responsible for

initiating all intravenous therapy in the hospital with the exceptions of the operating, delivery, and recovery rooms. All patient-care units where intravenous technicians were responsible for intravenous therapy were utilized in the study.

The second hospital (Hospital B) chosen for the study was a 400 bed private research-oriented hospital in close proximity to Hospital A. This hospital was chosen because it utilized an intravenous team of registered nurses for venipuncture in all patient-care areas, exclusive of the operating and recovery rooms. All patient-care units where intravenous nurses were responsible for intravenous therapy were included in the study.

The third hospital (Hospital C) included in this study was a 750 bed, non-profit community medical complex in a midtown location approximately three miles from Hospitals A and B. In Hospital C, staff nurses initiated intravenous infusions on patient-care units. All general medical-surgical patient care units were utilized in the study. Specialized units such as intensive care and recovery units were omitted from the study, because the investigator believed that nurses in these units received sufficient practice in venipuncture to acquire experience equal to the intravenous team nurses.

Sample

The sample consisted of 250 infusions administered to 250 patients. One hundred infusions were initiated by 34 staff nurses in Hospital C; 100 infusions were started by 11 intravenous technicians in Hospital A; and 50 infusions were performed by 3 intravenous nurse therapists in Hospital B. Only one infusion per patient was included in the sample.

Patients who met the following criteria were admitted to the study:

1. The venipuncture initiating the I.V. therapy was performed by an intravenous technician in Hospital A; by an intravenous nurse therapist in Hospital B; or by a staff nurse in Hospital C

2. The venipuncture initiated the first infusions recorded for the patient after the study began

3. The venipuncture was made with a scalp vein needle

4. The vein selected for the venipuncture was located in the forearm or back of the hand of either upper extremity.

5. The age of the patient was at least eighteen years and not more than sixty-five years

6. The patient was oriented to time, place, and person, and alert enough to cooperate with his therapy

7. The minimum length of the infusion was two hours

In selecting criteria for the sample, the investigator attempted to control certain variables believed to be associated with intravenous infiltration. Patients over sixty-five years of age were excluded to diminish the influence of the aging process on the veins; the lower age limitation was to admit people mature enough to cooperate (that is, variable of activity) with therapy and to eliminate the variable of smaller veins in children. The site of infusion was confined to the forearm and back of hand for matching purposes and, because those areas are less associated with infiltration.

Because in their studies Landry and Sylvester found the length of the needle to be significant in infiltration, all sample subjects were injected with the same kind of needle--the scalp vein needle. Criteria for selection of the needle were based on convenience and safety. The scalp vein needle was the most frequently used needle for intravenous injections in those hospitals utilized in the study and it, reportedly, facilitated the technique of venipuncture and was less associated with intravenous-related infections.

For purposes of study, the limit for the duration of infusions was set at eight hours. This arbitrary limitation was established for convenience of the investigator in interpretation of data. It was believed that infiltration

occurring after eight hours would be related to factors other than skill of the operator in initiating the infusion.

All patients who met the criteria for selection were included in the study. The convenience sampling method was used as opposed to random selection. The disease condition of the patient was not a sample criterion.

Instrument

The instrument that the investigator used for data collection was a modified form of the data collection card used by Landry in her study of factors related to infiltration during continuous intravenous therapy.¹ (See Appendix A, page 90.) The card's design minimized the length of recording time by listing responses that could be indicated by a check mark. The items included on the card were patient's hospital number, room number, age, and sex; date and time infusion was started; needle gauge; site of infusion (hand or forearm); name and title of person starting the infusion; presence or absence of infiltration; and time of infiltration. The cards measured four by six inches, a size convenient enough to be carried in the small tray of intravenous supplies, or in the technician's or nurse's pocket. The data collection cards were letter-coded for

¹Marjorie Landry, "Factors Related to Infiltration during Continuous Intravenous Therapy" (Master's thesis, Texas Woman's University, 1971), p. 64.

the three hospitals in order to simplify data compilation and avoid error.

Data Collection

A list of instructions for the study was formulated for inservice meetings to acquaint the personnel involved in the three hospitals with the study methodology. (See Appendix B, page 91.) These instructions included the purpose of the study, criteria for patient selection for the study, and method to be used in data collection. The instructions for use of the data collection card was a modification of the form used by Landry.¹ (See Appendix C, page 93.)

The investigator held these inservice meetings with the intravenous team members in Hospitals A and B and with the assistant director of nurses and medical and surgical nursing supervisors and head nurses in Hospital C. The list of instructions for the study was given to each participant in these meetings and opinions and recommendations were solicited. The instructions were approved by the supervisors and head nurses, who then relayed the information to the staff nurses of the units to be used in the study. Data collection cards and copies of the instructions for use of the data card were distributed to the intravenous therapy

¹Ibid., p. 66.

departments in Hospitals A and B and to each nursing station of the units utilized in Hospital C.

In Hospitals A and B, a technician or nurse initiated a data collection card each time he or she started an infusion with a scalp vein needle in the upper extremity of patients eighteen through sixty-five years of age. They recorded the patient's hospital number and room number, date and time infusion started, site of infusion (hand or forearm), and name and title of person starting the I.V. The cards were collected daily from the intravenous therapy departments and completed by the investigator as to age, sex, presence or absence of infiltration, and time of infiltration. The sources of data used for completion of the cards were the nursing personnel and the patient's hospital record.

With the cooperation of the medical and surgical nursing supervisors and the head nurses, staff nurses on four medical-surgical patient units in Hospital C were individually instructed in the use of the data card during morning and afternoon change-of-shift reports. Data collection cards were placed on the unit intravenous trays and staff nurses were asked to initiate a card each time they did a venipuncture for the purpose of starting an intravenous infusion. Instructions were kept to a minimum because of the large number of nurses to be reached and in

an attempt not to encumber the staff nurses with still more additional facts to remember. All cards initiated by the staff nurses were placed in a designated box near the intravenous tray. The first day of the study the investigator made rounds every two hours from 12:00 noon to 10:00 P.M. to sort the cards and complete the data on patients who met the criteria for sample selection. Visits to the units were reduced to once each eight-hour shift and then daily as the staff became more aware of the study.

In order to identify experience level of the individual starting each infusion, the investigator interviewed all nurses and technicians who participated in the study. The form developed for the interview was a chart listing participants' names and a columned checklist which contained items regarding education, training, supervised practice, and unsupervised practice in intravenous injection. (See Appendix D, page 94.)

The study was conducted over a period of twelve weeks. Infusions which were initiated between the hours of 7:00 A.M. and 11:00 P.M. daily were included in the study. Each infusion was studied for eight hours--or less if completed or discontinued sooner--for determination of presence or absence of infiltration. Data collection was completed in Hospitals A and C after eight weeks. The period of the study could not be extended long enough to collect

100 infusions in Hospital B where only three nurses comprised the intravenous team. A sample of fifty infusions was obtained in Hospital B during the last eight weeks of the twelve week study.

Method of Data Analysis

The individual data collection cards were tabulated as to presence or absence of infiltration of intravenous infusions initiated by the three groups--intravenous nurse therapists, intravenous technicians, and staff nurses. To compare the incidence of infiltration among the three groups, the chi-square non-parametric test was applied to the data with the level of significance at 0.05. The purpose of data analysis was to determine if there was a statistical difference between the dependent variable, infiltration and absence of infiltration, and the independent variable of experience in intravenous therapy.

CHAPTER IV

ANALYSIS AND DISCUSSION OF DATA

Introduction

This non-explanatory survey was conducted to compare the incidence of infiltration of intravenous infusions initiated by three groups of practitioners--intravenous technicians, intravenous nurse therapists, and staff nurses. The purpose of the study was to determine if experience in venipuncture was related to incidence of infiltration. Data were collected on 250 infusions administered to 250 patients: 100 infusions initiated by 11 intravenous technicians (Group A); 50 infusions started by 3 intravenous nurse therapists (Group B); and 100 infusions started by 34 staff nurses (Group C). The independent variable was identified as experience and the dependent variable was presence or absence of infiltration.

Experience was defined by the investigator to include the length of time the individual had been doing venipuncture, the approximate number of venipunctures done per week, and whether or not he or she had received special training in I.V. therapy. It was believed that skill in the procedure would be a product of that experience and must, therefore, be an integral part of every procedural element

associated with successful I.V. therapy (that is, absence of infiltration).

In so far as was possible those factors which had been related to infiltration by previous studies were controlled, in order to better isolate the factor of skill in the procedure. Only one type of needle (scalp vein) was used to initiate all infusions. The site of infusion was limited to the most favorably reported sites--the hand and the forearm. The age of the patient was limited to the years eighteen through sixty-five.

Two hypotheses were proposed by the investigator: (1) intravenous infusions initiated by individual staff nurses infiltrate more frequently than those initiated by intravenous nurse therapists and/or intravenous technicians, and (2) there is no significant difference in frequency of infiltration of infusions started by intravenous nurse therapists and intravenous technicians.

Presentation and Discussion of Findings

The findings are presented in three sections. The first section is a description of experience of the three study groups without statistical analysis. The second section pertains to the relationship of experience to infiltration, and the third section to the interrelatedness of

experience with the independent variables of site of infusion, age, and sex of the patient.

The non-parametric chi-square test of association was used for statistical analysis of the data. Calculations were made by a 6400 computer. The significance of the chi-square values were determined by adoption of the 0.05 level of significance, which had been used by Sylvester and Bruno and Landry in related studies.¹ Decisions regarding trends were made at the 0.10 probability level.

Comparative experience of the three study groups

A study was done to determine the relatedness of experience in performing venipuncture to incidence of infiltration of infusions initiated by three groups of practitioners. The following discussion attempts to quantitate and evaluate the distributions of the independent variable among the three participant groups in the study.

Experience of Group A. Group A consisted of eleven intravenous technicians. Nine were former medical corpsmen who had received special I.V. training in the armed forces (the reported actual exposure to I.V. therapy depended on

¹Marilyn Sylvester and Pauline M. Bruno, "Factors Associated with Infiltration during Continuous Intravenous Therapy," Nursing Research 15 (Summer 1966):256; and Marjorie Landry, "Factors Related to Infiltration during Continuous Intravenous Therapy" (Master's thesis, Texas Woman's University, 1971), p. 33.

individual assignments and varied from one day to three and one-half years). The remaining two members were licensed vocational nurses who were taught to do intravenous injections during a six week period in the hospital. To qualify for membership in the I.V. therapy team, each of the eleven practiced under supervision of the team leader or another qualified team member for six weeks. Table 1 shows the educational and experiential level of each technician who participated in the study. Those with twelve years formal education were high school graduates; those with thirteen years were licensed vocational nurses; and those with fourteen years had completed two years of college. There were two college graduates. For purposes of this study, experience refers to length of time doing venipunctures as intravenous technicians. As noted in Table 1, the infusions which were observed to infiltrate were initiated by technicians with ten or less months experience. Technician number eight with thirty-six months experience started sixteen infusions and none of these infiltrated. Three technicians with less than ten months experience started twenty-two infusions which did not infiltrate, and four technicians with more than twenty-four months experience initiated twenty-four successful infusions.

TABLE 1
EXPERIENCE LEVEL AND STUDY PARTICIPATION OF
EACH INTRAVENOUS TECHNICIAN IN GROUP A

Technician	Formal Education	Special I.V. Tr.	Experience (months)	Veni- punctures per Week	Observed Frequency	
					Infu- sions	Infiltra- tion
1	12 yrs.	Yes	5	60	11	1
2	14 yrs.	Yes	8	60	14	1
3	12 yrs.	Yes	2	60	8	1
4	12 yrs.	Yes	10	60	21	2
5 ^a	13 yrs.	Yes	7	60	8	0
6	16 yrs.	Yes	4	60	10	0
7	12 yrs.	Yes	25	60	4	0
8	14 yrs.	Yes	36	60	16	0
9 ^a	13 yrs.	Yes	7	60	4	0
10	16 yrs.	Yes	58	60	2	0
11	14 yrs.	Yes	58	60	2	0

^aLicensed vocational nurses

Experience of Group B. Each intravenous nurse therapist in Group B was a diploma-graduate registered nurse. The special training in venipuncture that each received was provided by the hospital and consisted of two days of observation and return demonstrations in the operating and recovery room under the supervision of an anesthesiologist. Table 2 depicts experience level of each. It may be noted that the nurse with eighteen months of experience had an observed infiltration frequency of 15 percent, while the nurse with thirty months experience demonstrated only 4 percent infiltration. Two of the three intravenous nurse therapists had received limited experience previously in their role as staff nurses. For purposes of this study, however, experience was measured on basis of present number of venipunctures performed per week.

Experience of Group C. Thirty-four staff nurses in Group C participated in the study and were interviewed by the investigator about their experience in venipuncture. Data obtained by interview are given in Table 3. All participants were registered nurses; only five had received special training in I.V. therapy. Those nurses indicated in Table 3 as having had special I.V. training were those who reported training of at least one week's duration. Nineteen nurses were taught venipuncture in their basic

TABLE 2

EXPERIENCE LEVEL AND STUDY PARTICIPATION OF EACH
INTRAVENOUS NURSE THERAPIST IN GROUP B

Nurse Therapist	Formal Education	Special I.V. Tr.	Experience (months)	Veni- punctures per Week	Observed Frequency	
					Infu- sions	Infiltra- tion
1	15 yrs.	Yes	30	50	25	1
2	15 yrs.	Yes	18	50	20	3
3	15 yrs.	Yes	6	20	5	0

TABLE 3
EXPERIENCE LEVEL AND STUDY PARTICIPATION OF
STAFF NURSES IN GROUP C

Staff Nurse	Formal Education	Special I.V. Tr.	Experience (months)	Veni-punctures per Week	Observed Frequency	
					Infusions	Infiltration
1	16 yrs.	No	3	6-10	13	3
2	16 yrs.	No	120	10-12	4	1
3	16 yrs.	No	156	15	1	1
4	14 yrs.	Yes	36	10-12	6	2
5	16 yrs.	Yes	18	6	1	1
6	14 yrs.	No	9	2- 3	1	1
7	16 yrs.	No	300	5- 7	8	1
8	16 yrs.	No	36	5	8	0
9	16 yrs.	No	144	2	3	0
10	16 yrs.	No	54	3	2	0
11	15 yrs.	No	120	10-12	3	0
12	16 yrs.	No	24	12-15	4	0
13	15 yrs.	No	84	15-16	3	0
14	16 yrs.	No	144	12-15	8	0
15	14 yrs.	No	24	2	1	0

TABLE 3--Continued

Staff Nurse	Formal Education	Special I.V. Tr.	Experience (months)	Veni-punctures per Week	Observed Frequency	
					Infusions	Infiltration
16	15 yrs.	No	252	12-15	5	0
17	16 yrs.	No	192	5	2	0
18	16 yrs.	No	120	4- 5	1	0
19	15 yrs.	No	60	10	1	0
20	16 yrs.	No	36	5- 6	3	0
21	14 yrs.	No	48	12	3	0
22	15 yrs.	Yes	2	1	2	0
23	15 yrs.	No	12	2	1	0
24	15 yrs.	No	36	4	3	0
25	15 yrs.	No	24	1	1	0
26	16 yrs.	No	300	5	1	1
27	15 yrs.	No	240	10	2	0
28	15 yrs.	Yes	240	8	1	0
29	15 yrs.	No	36	6	1	0
30	14 yrs.	No	60	5	1	0
31	16 yrs.	No	36	10	1	0
32	15 yrs.	No	24	6	2	0
33	16 yrs.	Yes	48	20	2	0
34	14 yrs.	No	2	1	1	0

nursing education, but explained that this consisted only of demonstration and sometimes a return demonstration. Five nurses reported that they received some instruction from inservice during orientation to the hospital. The remaining five nurses received no formal instruction. All nurses, however, had access to extensive instruction in I.V. therapy contained in the procedure manual at each nursing station.

Education of staff nurses varied as follows: six were associate degree graduates; twelve were diploma graduates; and sixteen had baccalaureate preparation. As shown in Table 3, eighteen staff nurses had less than 50 months of experience in venipuncture; four nurses had been performing venipuncture 50-100 months; five had experience level of 100-150 months; and seven had done venipuncture for over 150 months. Fourteen nurses performed only one infusion each and three of these infiltrated. The three nurses who initiated the infiltrated infusions had experience ranging from 9 to 156 months and reported performing an average of 2-15 venipunctures per week. The first seven nurses in Table 3 experienced an infiltration frequency ranging from 12.5 to 100 percent. Nurse number one with the most infusions (thirteen) and most observed infiltrations (three) reported three months experience doing venipuncture and six to ten venipunctures performed per week.

The mean levels of experience of the three groups as depicted in Fig. 3 were as follows: (1) Group A had mean length of experience of twenty months and sixty venipunctures per week, (2) Group B had been doing venipunctures for eighteen months at forty injections per week, and (3) Group C had been doing seven venipunctures per week for ninety-five months. As illustrated in Fig. 3, the mean level of experience of Group C is greater in length than Groups A and B, but the experience was without special training in I.V. therapy and involved only seven venipunctures per week. The graph shows that Group A had the most experience in terms of total number of venipunctures performed.

Relationship of experience to infiltration

Experience in venipuncture of three groups was studied to determine its effect upon infiltration in I.V. therapy. Data about experience were obtained by individual interview from eleven intravenous technicians (Group A), three intravenous nurse therapists (Group B), and thirty-four staff nurses (Group C). By comparing length of time doing intravenous injection and number of venipunctures per week among the members of the three groups, a mean level of experience for each group was found. Mean length of experience exceeded seventeen months in all three groups. The deciding factor for practice of the skill was, therefore,

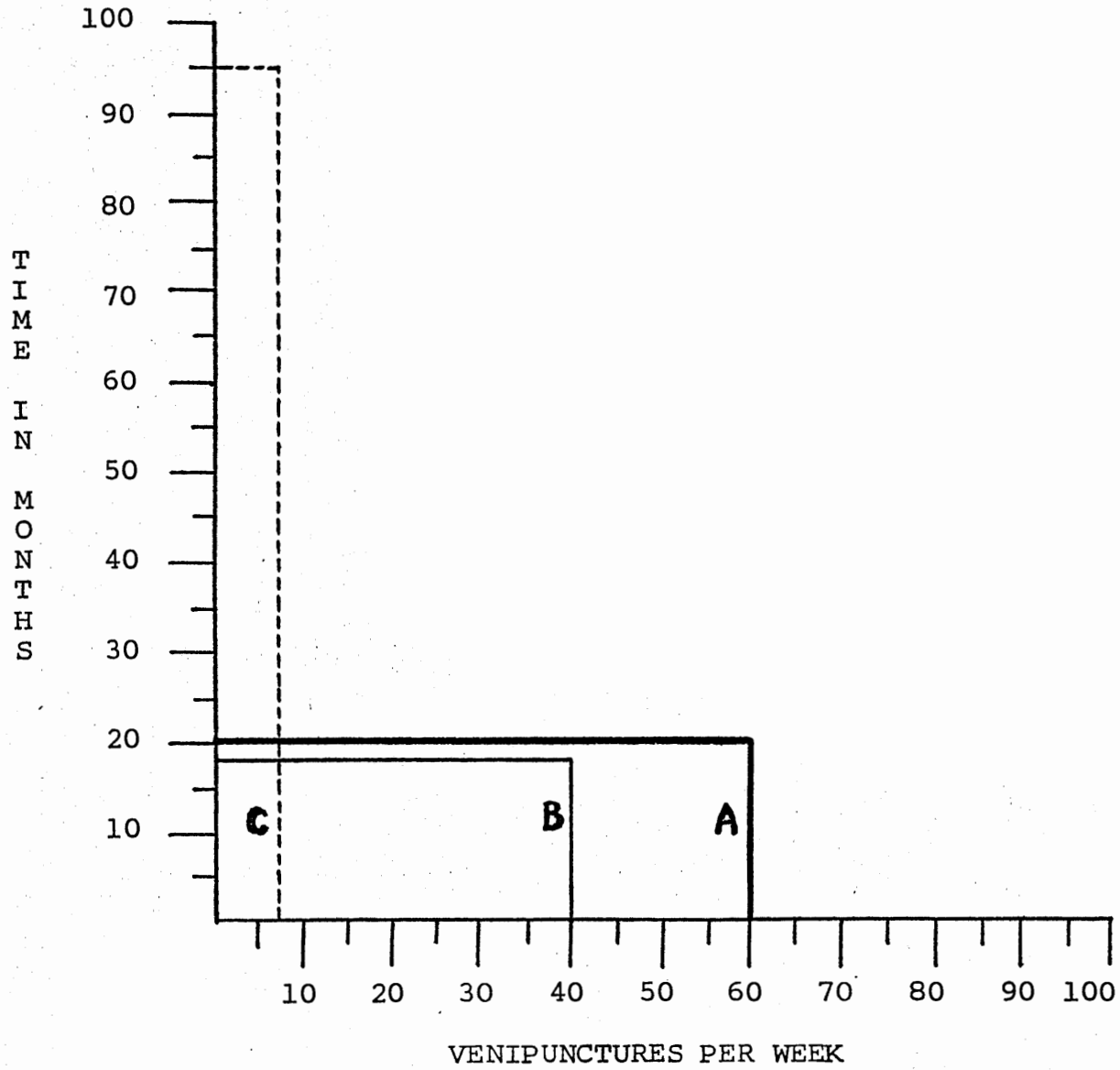


Fig. 3. Mean level of experience of three groups

determined by the investigator to be number of venipunctures performed per week. Using the above indices, Group A had the greater experience level (60 venipunctures per week for 20 months), Group B experience (40 venipunctures per week for 18 months) was less than Group A, and Group C had the least experience (7 venipunctures per week for 95 months).

The relationship of the independent variable (experience) to infiltration is shown in Table 4. Five (5 percent) of the 100 infusions in Group A infiltrated; four (8 percent) of the 50 infusions in Group B infiltrated; and ten (10 percent) of the 100 infusions in Group C infiltrated. Using the chi-square test of association to compute the data, no statistical difference was found in the incidence of infiltration among the three groups.

TABLE 4

RELATIONSHIP OF EXPERIENCE (INDEPENDENT VARIABLE)
TO INCIDENCE OF INFILTRATION

Group	Infusions	Observed Frequency		Chi Square	p ^a
		Infiltration	Noninfiltration		
A	100	5	95	1.7942	N.S.
B	50	4	46		
C	100	10	90		

^adf = 2 for chi-square value

To determine if there would have been a statistical difference if the sample size had been equal in all three groups, the chi-square test was applied to data for the first fifty infusions in each group. As shown in Table 5, during the first fifty infusions studied in each group there occurred three (6 percent) infiltrations in Group A, four (8 percent) infiltrations in Group B, and five (10 percent) infiltrations in Group C. The chi-square value of 0.5434 was non-significant.

TABLE 5

RELATIONSHIP OF EXPERIENCE (INDEPENDENT VARIABLE) TO
INCIDENCE OF INFILTRATION IN FIRST FIFTY INFUSIONS

Group	Infusions	Observed Frequency		Chi Square	p ^a
		Infiltration	Noninfiltration		
A	50	3	47	0.5434	N.S.
B	50	4	46		
C	50	5	45		

^adf = 2 for chi-square value

Data tested to determine a statistical difference between infiltration of infusions started by intravenous technicians (Group A) and intravenous nurse therapists (Group B) also proved non-significant as shown in Table 6.

TABLE 6

RELATIONSHIP OF EXPERIENCE (INDEPENDENT VARIABLE) TO
INFILTRATION BETWEEN GROUPS OF INTRAVENOUS
TECHNICIANS AND NURSE THERAPISTS

Group	Infu- sions	Observed Frequency		Chi Square	p ^a
		Infiltra- tion	Noninfil- tration		
A	100	5	95	0.1392	N.S.
B	50	4	46		

^adf = 1 for chi-square value

From computation of above data, decisions were made relative to the hypotheses of the study.

Hypothesis 1--Intravenous infusions initiated by individual staff nurses infiltrate more frequently than those initiated by intravenous nurse therapists and/or intravenous technicians. This hypothesis was rejected.

Hypothesis 2--There is no significant difference in frequency of infiltration of infusions started by intravenous nurse therapists and intravenous technicians. This hypothesis was retained.

Interrelatedness of independent variables to infiltration

During the process of data collection, information regarding certain other factors (age, sex, and site of infusion) was also obtained. Although it was not the purpose

of this study to do so, this investigator became interested in determining if there was an interrelationship of experience in venipuncture with the independent variables of age, sex, and site of infusion. Landry studied the interrelatedness of independent variables and found four significant relationships to infiltration. Her findings relevant to this study indicated that infiltration was significantly related to (1) use of scalp vein needles for infusions in male patients, (2) use of scalp vein needles for infusions in the hand, and (3) use of the forearm as infusion site in male patients.¹ Although the scalp vein needle was used exclusively in this study, the investigator attempted to verify similar relationships or determine new ones. The chi-square test was used to measure interrelatedness of the independent variables to infiltration.

Interrelatedness of experience with other independent variables. The independent variables of age, sex, and site of infusion were computed as to presence or absence of infiltration within each study group. The distribution of patients according to sex, age, and site of infusion within each group is given in Table 7. In Group A, sixty-eight patients receiving infusions were female and thirty-two were male. Forty of the fifty patients in

¹Landry, "Factors Related to Infiltration," p. 53.

Group B were female and ten were male; in Group C, there were sixty-two females and thirty-eight males. The hand was the site of infusion in thirty-two patients in Group A, twenty-two patients in Group B, and fifty-three patients in Group C. The forearm was utilized as site of infusion in the remaining sixty-eight patients in Group A, twenty-eight patients in Group B, and forty-seven patients in Group C. The mean age of the patients in the three groups was 39.9, 45.3, and 46.5, respectively.

TABLE 7
DISTRIBUTION OF PATIENTS ACCORDING TO
AGE, SEX, AND SITE OF INFUSION
WITHIN EACH GROUP

Group	Age		Sex				Site of Infusion			
			Male		Female		Hand		Forearm	
	Mean	Median	I	N	I	N	I	N	I	N
A	39.9	39	2	30	3	65	3	29	2	66
B	45.3	45	0	10	4	36	1	21	3	25
C	46.5	48	4	34	6	56	3	50	7	40

I = Infiltration
N = Noninfiltration

The breakdown of age above and below the mean according to presence or absence of infiltration in each group is included in Table 8, which shows the chi-square values for relationship of age, sex, and site of infusion

TABLE 8

RELATIONSHIP OF THREE INDEPENDENT VARIABLES
TO INFILTRATION, BY GROUPS

Variables	Infusions	Observed Frequency		Chi Squares	p ^a
		Infiltration	Noninfiltration		
Group A					
Site					
Hand	32	3	29	0.7836	N.S.
Forearm	68	2	66		
Age					
> $\bar{X}$ 39.9	49	2	47	0.0021	N.S.
< $\bar{X}$ 39.9	51	3	48		
Sex					
Male	32	2	30	0.0096	N.S.
Female	68	3	65		
Group B					
Site					
Hand	22	1	21	0.0745	N.S.
Forearm	28	3	25		
Age					
> $\bar{X}$ 45.3	25	2	23	0.2717	N.S.
< $\bar{X}$ 45.3	25	2	23		
Sex					
Male	10	0	10	0.1528	N.S.
Female	40	4	36		
Group C					
Site					
Hand	53	3	50	1.4452	N.S.
Forearm	47	7	40		
Age					
> $\bar{X}$ 46.5	57	2	55	4.6421	<0.05
< $\bar{X}$ 46.5	43	8	35		
Sex					
Male	38	4	34	0.0424	N.S.
Female	62	6	56		

^adf = 1 for all chi-square values

to infiltration within each study group. No significant relationships were found to exist between the variables of sex and site of infusion and infiltration when infusions were started with scalp vein needles by intravenous technicians, intravenous nurse therapists, or staff nurses. A relationship was noted, however, in Group C which indicated that infusions infiltrated more frequently in patients below the mean age of 46.5 years. Fifty-seven patients above the mean age received infusions and two (3.5 percent) infiltrated; forty-three patients below the mean age received infusions and eight (18.6 percent) infiltrated. As shown in Table 8, this represented a chi-square value of 4.6421 which is greater than the 0.05 probability level of 3.84 and, therefore, is significant. This relationship is in contrast to a trend noted by Landry which indicated infusions infiltrated more frequently in patients above a mean age of 49.7 years.¹ Her finding that infiltration was significantly related to scalp vein needles and hand as site of infusions was not supported, nor was her finding of a significant relationship between infiltration and the use of scalp vein needles to start infusions in male patients.²

To further determine if experience was interrelated with other independent variables, each variable (hand,

¹Ibid., p. 53. ²Ibid., pp. 42, 51.

forearm, age below the mean, age above the mean, male sex, female sex) was compared with incidence of infiltration among the three groups by computation of the chi-square value for each. Data analysis for interrelatedness of experience with each variable is shown in Table 9. A significant relationship was found between experience and age below the study mean of 43.9 years with a chi-square value of 6.9828. In Group A, two (3.7 percent) patients below the mean age experienced infiltration; two (8.7 percent) patients in Group B below the mean age had infusions which infiltrated; and in Group C, eight (20.5 percent) patients below the mean age experienced infiltration.

Table 9 also shows a trend indicating an interrelationship between experience and use of the forearm as site of infusion. The chi-square value was 5.4090 which is above the 0.10 probability level of 4.61. Of those infusions started in the forearm, two (3 percent) infiltrated in Group A, three (10.7 percent) infiltrated in Group B, and seven (14.9 percent) infiltrated in Group C.

It was concluded that infiltration occurs more frequently when less experienced practitioners initiate infusions with a scalp vein needle in the forearm of patients below the mean age of 43.9 years.

TABLE 9

INTERRELATEDNESS OF EXPERIENCE WITH OTHER
VARIABLES TO INFILTRATION

Variables	Infusions	Observed Frequency		Chi Square	p ^a
		Infiltration	Noninfiltration		
Site--Hand					
Group A	32	3	29	0.6308	N.S.
Group B	22	1	21		
Group C	53	3	50		
Site--Forearm					
Group A	68	2	66	5.4090	<0.10
Group B	28	3	25		
Group C	47	7	40		
Male Sex					
Group A	32	2	30	1.3845	N.S.
Group B	10	0	10		
Group C	38	4	34		
Female Sex					
Group A	68	3	65	1.6833	N.S.
Group B	40	4	36		
Group C	62	6	56		
Age $\bar{X}$ 43.9					
Group A	54	2	52	6.9828	<0.05
Group B	23	2	21		
Group C	39	8	31		
Age $>\bar{X}$ 43.9					
Group A	46	3	43	0.8827	N.S.
Group B	27	2	25		
Group C	61	2	59		

^adf = 2 for all chi-square values

Interrelatedness of site of infusion and age and sex to infiltration. No statistical relationship between the hand as site of infusion and age or sex was found in any of the three study groups. Table 10 shows that all chi-square values were below the 0.10 probability level of 2.71.

Data analysis to determine interrelatedness of the forearm as site of infusion and the variables of age and sex were non-significant as shown in Table 11. A trend appeared, however, in the relationship of forearm as site of infusion in patients below the mean age of 46.5 in Group C. Twenty-two infusions were started in the forearm in patients below the mean age and six (27.3 percent) infiltrated; of those patients above the mean age receiving infusions in the forearm, only one (4 percent) infiltrated. This represents a chi-square value of 3.3328. As noted before, there was an interrelationship between forearm as site of infusion and age below the mean when infusions were started by staff nurses. It is interesting that in Group A, even though one of three (33.3 percent) infusions started in the forearm of males infiltrated, and one of forty-four (2.3 percent) infusions started in the forearm of females infiltrated, a significant trend did not occur. The chi-square value of 1.2116 indicated that a relationship did not exist between infiltration and the use of the forearm as site of infusion in male patients when the venipuncture was performed by

TABLE 10

INTERRELATEDNESS OF HAND AS SITE OF INFUSION AND
AGE AND SEX TO INFILTRATION IN EACH GROUP

Variables	Infusions	Observed Frequency		Chi Square	p ^a
		Infiltration	Noninfiltration		
Age					
Group A					
< $\bar{X}$ 39.9	16	1	15	0.0012	N.S.
> $\bar{X}$ 39.9	16	2	14		
Group B					
< $\bar{X}$ 45.3	10	0	10	0.0921	N.S.
> $\bar{X}$ 45.3	18	1	17		
Group C					
< $\bar{X}$ 46.5	20	2	18	0.2035	N.S.
> $\bar{X}$ 46.5	33	1	32		
Sex					
Group A					
Male	24	2	22	0.1126	N.S.
Female	8	1	7		
Group B					
Male	16	1	15	0.2728	N.S.
Female	6	0	6		
Group C					
Male	30	0	30	1.3752	N.S.
Female	26	3	23		

^adf = 1 for all chi-square values

TABLE 11

INTERRELATEDNESS OF FOREARM AS SITE OF INFUSION AND
AGE AND SEX TO INFILTRATION IN EACH GROUP

Variables	Infusions	Observed Frequency		Chi Square	p ^a
		Infiltration	Noninfiltration		
Age					
Group A					
< $\bar{X}$ 39.9	34	1	33	0.5151	N.S.
> $\bar{X}$ 39.9	34	1	33		
Group B					
< $\bar{X}$ 45.3	15	2	13	0.0172	N.S.
> $\bar{X}$ 45.3	13	1	12		
Group C					
< $\bar{X}$ 46.5	22	6	16	3.3328	<0.10
> $\bar{X}$ 46.5	25	1	24		
Sex					
Group A					
Male	3	1	2	1.2116	N.S.
Female	44	1	43		
Group B					
Male	4	0	4	0.0155	N.S.
Female	24	3	21		
Group C					
Male	5	1	4	0.8763	N.S.
Female	32	6	26		

^adf = 1 for all chi-square values

intravenous technicians. Landry found a significant relationship between infiltration and use of the forearm as site of infusions in male patients when infusions were initiated by a group of intravenous technicians.¹

Interrelatedness of age and sex to infiltration. As shown in Table 12, analysis of the data revealed no inter-relationship between male sex and age of the patient; nor were any trends noted.

TABLE 12

INTERRELATEDNESS OF MALE SEX AND AGE
TO INFILTRATION IN EACH GROUP

Variables	Infusions	Observed Frequency		Chi Square	p ^a
		Infiltration	Noninfiltration		
Age					
Group A					
< $\bar{X}$ 39.9	14	0	14	0.3047	N.S.
> $\bar{X}$ 39.9	18	2	16		
Group B					
< $\bar{X}$ 45.3	2	0	2	Cannot Compute (two zero values)	
> $\bar{X}$ 45.3	8	0	8		
Group C					
< $\bar{X}$ 46.5	16	3	13	0.7628	N.S.
> $\bar{X}$ 46.5	22	1	21		

^adf = 1 for all chi-square values

¹Landry, "Factors Related to Infiltration," p. 43.

Table 13 shows no significant relationship between female sex and age in either Group A, B, or C. A near trend was noted, however, which indicated a possible relationship between female sex and age below the mean of 46.5 years in Group C. The chi-square value of 2.6729 was very close to the 0.10 probability level of 2.71. Five (18.5 percent) of the twenty-seven female patients below the mean age of 46.5 infiltrated, and only one (2.9 percent) of the thirty-five patients above the mean age experienced infiltration. In summary, no significant interrelationship was found to exist between age and sex of the patient and presence of infiltration.

TABLE 13

INTERRELATEDNESS OF FEMALE SEX AND AGE
TO INFILTRATION IN EACH GROUP

Variables	Infusions	Observed Frequency		Chi Square	p ^a
		Infiltration	Noninfiltration		
Age					
Group A					
< $\bar{X}$ 39.9	37	2	36	0.0246	N.S.
> $\bar{X}$ 39.9	31	1	30		
Group B					
< $\bar{X}$ 45.3	23	2	21	0.0454	N.S.
> $\bar{X}$ 45.3	17	2	15		
Group C					
< $\bar{X}$ 46.5	27	5	22	2.6729	N.S.
> $\bar{X}$ 46.5	35	1	34		

^adf = 1 for all chi-square values

Summary of Findings

Data collected on 250 infusions initiated by three groups of practitioners with differing levels of experience in venipuncture were analyzed for the purpose of identifying the relationship of experience to infiltration. The chi-square values for relationship of experience to infiltration were not significant. The first hypothesis of this study which predicted that infusions by staff nurses would infiltrate more frequently than those by intravenous technicians and/or intravenous nurse therapists was rejected. The second hypothesis was retained--there was no significant difference between frequency of infiltration of infusions initiated by intravenous technicians and intravenous nurse therapists.

It was found, however, that mean experience of the group (using the indices of length of time doing venipunctures and number of venipunctures performed per week) did correspond in a reciprocal relationship to the actual percentage of infiltration of each group (that is, the more experience, the less infiltration). The frequency of infiltration for the group of intravenous technicians was 5 percent. The mean length of time doing venipuncture for the group was twenty months and mean number of venipunctures was sixty per week. The intravenous nurse therapist group with an infiltration frequency of 8 percent had a mean length of

time doing venipunctures of eighteen months, and mean number of venipunctures of forty per week. The group of staff nurses had the highest frequency of infiltration (10 percent) and lowest mean experience (ninety-five months doing seven venipunctures per week).

Because certain predictions as to interrelatedness of selected variables to infiltration had been made by Landry, data were computed using the chi-square test at 0.05 level of significance to determine a relationship between experience and site of infusion, age, and sex of the patient with incidence of infiltration. A significant relationship was found to exist between infiltration and patient age when staff nurses started infusions using scalp vein needles. Infusions infiltrated more frequently in patients below the mean age of 43.9 years for the study sample and 46.5 years for Group C. In addition, a trend was noted involving the interrelatedness of independent variables to infiltration: The incidence of infiltration increased when the forearm was the site of infusion utilized by staff nurses.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This non-explanatory study was conducted for the purpose of determining a relationship between experience in venipuncture and incidence of infiltration in intravenous therapy. Three groups of practitioners with varying levels of experience were included in the study--eleven intravenous technicians, three intravenous nurse therapists, and thirty-four staff nurses. Hypotheses for the study predicted that (1) infusions initiated by staff nurses would infiltrate more frequently than those started by intravenous technicians and/or intravenous nurse therapists, and (2) there would be no statistical difference in incidence of infiltration of infusions started by technicians and intravenous nurse therapists.

The study was conducted for a period of twelve weeks in three hospitals. Data were collected concurrently on 100 infusions initiated by intravenous technicians in one hospital for three weeks; 50 infusions started by intravenous nurse therapists in a second hospital for eight weeks; and 100 infusions started by staff nurses in a third hospital for five weeks. Only one infusion per patient was included

in this study. All infusions were initiated with three-fourths inch scalp vein needles in the hand or forearm of patients between the ages of eighteen and sixty-five years. The method of data collection was replicated, in part, from Landry's study in that data from the intravenous therapist's record, the patient's hospital record, and the patient were entered by the technicians, nurses and/or the investigator on a data collection card.¹

The individual data collection cards were tabulated as to presence or absence of infiltration for each group of practitioners. The chi-square test of association was applied to the data to determine statistical significance of the relationship of experience to infiltration, and inter-relatedness of experience with site of infusion, and age, and sex of the patient to infiltration.

Conclusions

The finding of this study was that experience in venipuncture was not significantly related to infiltration. The first hypothesis was rejected; the second was retained.

One significant interrelationship of experience and other variables was identified: Infiltration occurred more

¹Marjorie Landry, "Factors Related to Infiltration during Continuous Intravenous Therapy" (Master's thesis, Texas Woman's University, 1971), p. 56.

frequently when staff nurses initiated infusions in patients below the mean age. This relationship was significant for incidence of infiltration both within Group C (mean age 46.5 years) and when compared among the total study sample (mean age 43.9 years). In addition to these significant findings, a trend was noted in which the incidence of infiltration increased when the forearm was the site of infusion utilized by staff nurses.

The actual percentage of infiltration in this study (5, 8, and 10 percent) compared favorably with data reported by related studies. Landry with a sample of 330 infusions reported a 34.2 percent incidence of infiltration, and Sylvester and Bruno reported that 20.4 percent of their 103 infusions infiltrated.¹ As these investigators used experienced intravenous teams to collect data, it would appear that differences in other independent variables must account for the greater incidence of infiltration in those studies.

Some differences in study populations and methodologies are obvious. The sample population for this study was predominantly female in contrast to the larger percentage of males in the studies done by Landry and Sylvester and Bruno. The age of the population was limited

¹Ibid., p. 33; and Marilyn Sylvester and Pauline M. Bruno, "Factors Associated with Infiltration during Continuous Intravenous Therapy," Nursing Research 15 (Summer 1966):256.

to the years eighteen through sixty-five in this study, while patient age ranged from fifteen through ninety in the Landry study and fifteen through eighty-nine in the Sylvester and Bruno study. Landry found a trend toward a relationship between age above the population mean and infiltration; in the Sylvester and Bruno study only one of the twenty-one infusions which infiltrated was administered to a patient under fifty years of age.¹ The finding in this study that infiltration increased when staff nurses started infusions in patients below the mean age may have been reversed had patients above the age of sixty-five been admitted to the study. It appeared to the investigator during data collection that a greater incidence of infiltration was occurring in older patients not included in this study--and most frequently in infusions lasting longer than twelve hours.

Another factor which may have influenced the lower percentage of infiltration in this study was the lack of multiple venipunctures per patient. Although the patients received multiple infusions, only one infusion per patient was studied and that was usually the first occurring during the study; this study omitted any second (or later) venipuncture.

The most obvious difference in methodology between the three studies was the choice of needle used. The scalp

¹Ibid., p. 37; and Ibid., p. 258.

vein needle was used exclusively in this study; it was not used by Sylvester and Bruno; it was compared with one-inch metal needles in Landry's study.¹ The advantages of the scalp vein needle have been reported in the review of literature. Nurse therapists in Hospital B, utilized in this study, who used intravenous catheters predominantly for continuous intravenous therapy, have since been instructed by the hospital infection control committee to use scalp vein needles exclusively. Perhaps further study of the scalp vein needle is warranted for not only its relationship to phlebitis but also to infiltration.

Admittedly, a probable Hawthorne effect did exist in the study, as each team knew they were to be compared with other hospital groups. This investigator believed, however, that this knowledge would not minimize the independent variable (skill as the product of experience) but serve to enhance it and equally so among the three groups.

Recommendations

Based on the findings of this study, the following recommendations for further study are made:

1. Replication of the study using the same methodology but including the following changes:
 - a. Larger sample

¹Ibid., p. 33; and Ibid., p. 255.

- b. Extending age limit to include patients older than sixty-five
- c. Have better control of reporting of infusions
- d. Study infusions for twelve hours or longer

2. Replication of the study with suggested changes and expanding factors studied to include condition of veins, number of venipunctures, activity of the patient, drugs and solutions used, and disease condition

3. Replication of this study with larger sample to verify or disprove interrelationship of factors discovered in this study to be associated with increased incidence of infiltration (that is, the use of scalp vein needles by staff nurses to start infusions in the forearm of patients below the age of 46.5 years).

APPENDIX A

DATA COLLECTION CARD

Patient's Hospital No. _____ Date _____
Room No. _____ Age _____ Sex _____ Time _____
Needle Used: Scalp vein _____ Other _____
Needle Gauge: 18____ 19____ 20____ 21____ 22____ 23____
Site of Infusion: Hand _____ Forearm _____
Infusion Started by _____ (Name)
I.V. Nurse _____ I.V. Technician _____ Staff Nurse _____

(To be filled out by investigator)

Infiltrated? Yes _____ No _____ Time _____
Completed? _____ Discontinued? _____ Time _____
Infusion Patent after 8 hours? _____ Time _____

APPENDIX B

INSTRUCTIONS FOR I.V. INFILTRATION STUDY

Purpose of Study: The purpose of this study is to study infusions initiated by three groups--intravenous nurse therapists, intravenous technicians, and staff nurses doing venipuncture. The incidence of infiltration will be compared between the three groups of infusions in an attempt to answer the question: "Is experience in intravenous injection related to I.V. infiltration?"

- I. Data collection cards are to be initiated when an infusion, which meets the following conditions, is started:
 - A. It is the patient's first infusion of the study
 - B. Infusion started between 7:00 A.M. and 11:00 P.M.
 - C. The infusion is started with a scalp vein needle
 - D. The infusion is started in either the forearm or back of hand
 - E. The patient is between the ages of 18 and 65
 - F. The patient is oriented and cooperative
- II. Instructions for the use of the data card will be distributed to I.V. Therapy Departments and all patient care units (utilized in the study) where staff nurses do venipuncture.
- III. The investigator will complete the cards. It would be very helpful if infiltration or discontinuance of the infusion is charted on the patient's record.
- IV. Each infusion will be followed for eight hours. Each morning the investigator will visit the hospitals where I.V. teams work to complete cards. In the hospital where staff nurses do the I.V. injections, the investigator will make rounds every two hours from 12:00 noon to 10:00 P.M. the first day, then every eight hours for the first few days, and after that once each day to complete data card information, and follow-up on previous infusions.
- V. Data for 100 infusions that meet the above criteria will be collected in each hospital.

- VI. The investigator will interview each nurse and technician participating in the study to determine amount of experience such as education, specialized training, and so forth.

APPENDIX C

INSTRUCTIONS FOR USE OF DATA COLLECTION CARD

- I. Intravenous Nurse, Technician, Staff Nurse
 - A. Please initiate a data collection card for each venipuncture done with a scalp vein needle performed on a cooperative patient (18-65 years of age) for the purpose of administering an infusion, when that infusion is the patient's first infusion of the study and when it is started in a vein in the forearm or back of the hand.
 - B. Complete the following information
 1. Patient's hospital number
 2. Room number
 3. Date
 4. Time infusion started
 - C. Place a check mark in the appropriate space for
 1. Needle used
 2. Needle gauge
 3. Site used
 - D. Please sign card and check title.
 - E. Return card to Intravenous Therapy Department or box provided near I.V. tray on hospital units.
- II. The investigator will collect the cards daily and complete the remainder of the information requested.

Thank you,

Patsy G. Martin, R.N.
Graduate Student
Texas Woman's University

APPENDIX D

INTERVIEW DATA

Nurse or Tech- nician	Formal Education					Training in I.V. Therapy				Length of Special Training		Supervised Practice			How Long Been Doing Venipunc- tures (Months)	Approx No. of Venipunc- tures Per Wk
	Hi Sch	Col	ADN	Dip	BSN	No	Nur Sch	Hosp	Armed ^a Forces	No. Days	No. Weeks	No	Yes	How Long		
Group A																
1	X							X	X		6		X	6 wk	5	60
2		Soph						X	X		6		X	6 wk	2	60
3	X							X	X		6		X	6 wk	2	60
4	X							X	X		6		X	6 wk	10	60
5		LVN						X			6		X	6 wk	7	60
6		X						X	X		6		X	6 wk	4	60
7	X							X	X		6		X	6 wk	25	60
8		Soph						X	X		6		X	6 wk	36	60
9		LVN						X			6		X	6 wk	7	60
10		X						X	X		6		X	6 wk	58	60
11		Soph						X	X		6		X	6 wk	58	60
Group B																
1				X				X		2			X	2 da	30	50
2				X				X		2			X	2 da	18	50
3				X				X		2			X	2 da	6	20
Group C																
1					X		X			1 ^b		X			3	6-10
2					X		X			1		X			120	10-12
3					X		X			1 ^b		X			156	15
4			X				X	X			1	X			36	10-12
5				X			X				4		X	4 wk	18	6
6			X					X		1 ^b		X			9	2- 3
7				X			X			1 ^b		X			300	5- 7
8				X			X			1 ^b		X			36	5
9				X			X			1 ^b		X			144	2
10				X				X		1		X			54	3
11				X			X	X		1			X	1 wk	120	10-12
12				X		X						X			24	12-15
13				X		X						X			84	15-16
14				X		X		X		1		X			144	12-15
15			X			X						X			4	2
16			X			X		X		1		X			252	12-15
17				X		X		X		1 ^b		X			192	5
18				X		X		X		1 ^b		X			120	4- 5
19				X		X						X			60	10
20				X		X						X			36	5- 6
21			X			X				1 ^b		X			48	12
22			X			X		X			1		X	1 wk	2	1
23			X					X		1 ^b		X			12	2
24			X			X						X			35	4
25			X			X		X		1 ^b		X			24	1
26				X		X						X			300	5
27			X			X						X			240	10
28			X			X		X			1	X			240	8
29			X			X						X			36	6
30			X			X		X		1 ^b		X			60	5
31				X		X						X			36	10
32				X		X						X			24	6
33				X		X		X			1				48	30
34			X			X						X			2	1

^aReported actual exposure to I.V. therapy prior to civilian hospital employment depended on assignment and varied from one day to three and one-half years.

^bThese participants had attended only one class period.

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