The American Academy of Pediatrics and the Centers for Disease Control and Prevention have endorsed the use of oral rehydration therapy (ORT) as first-line therapy in children with mild to moderate dehydration. While some emergency departments try to facilitate ORT by appropriate teaching or by the use of oral ondansetron, many do not. Intravenous therapy (IVT) is usually ordered, but it is not easily initiated. In fact, peripheral difficult venous access in children has been and continues to be a common problem in today’s emergency departments.3

In severely dehydrated children and in children with symptoms of hypovolemic shock, IVT is the recommended first-line therapy. The American Heart Association Pediatric Advanced Life Support (2006) guidelines for rehydration in obtunded or comatose children due to hypovolemia who have difficult venous access recommends intraosseous infusion of fluid as an alternate route for rapid fluid administration4; however, for children who are conscious and mildly to moderately dehydrated, intraosseous insertion is not an option without adequate sedation. Some evidence indicates that insertion of a nasogastric tube for ORT may be helpful, but it is not without complications, such as aspiration or ileus.5 Most recently, the use of subcutaneous rehydration therapy (SCRT) has resurfaced as an alternative for rehydration therapy when ORT has failed or when IVT is difficult to achieve in children with mild to moderate dehydration.6 The purpose of this article is to familiarize the emergency nurse with the SCRT technique and to answer some of the questions most frequently asked about this therapy by nurses and parents.

Subcutaneous Rehydration Therapy

The physiology of SCRT involves the appropriate functioning of a sodium-potassium pump, which will allow for an osmotic gradient to occur when the concentration of fluid is greater in one area than another. This mechanical pump facilitates the movement of fluid from an area of high concentration to one of low concentration. The subcutaneous tissue is a dense matrix of hyaluronic acid (hyaluronan), and it delays the absorption of subcutaneous fluid into the vascular compartment when fluid is infiltrated. Hyaluronidase, a naturally occurring enzyme, breaks down the hyaluronan and allows a new matrix to form about every 24 hours. By injecting a small amount of a hyaluronidase (hylenex, vitrase, wydase, or hydase; 150 or 200 USP units/mL: 1 mL single-dose vial) into a subcutaneous area, the matrix will be temporarily broken down and allow a space to develop under the skin for fluid to be infused and more readily absorbed. Ultimately, the time of absorption from the infiltrate into the vascular compartment and capillary beds is enhanced when the matrix barrier (hyaluronan) is removed.

Indications for SCRT are (1) when parenteral rehydration therapy is needed in mildly to moderately dehydrated patients in whom ORT has failed and (2) when patients with DVA who are not in a life-threatening state require fluid rehydration. Contraindications for using SCRT augmented with hyaluronidase include allergy to bee stings, infusion in an area of cellulitis, severe hyponatremia (Na < 130), or hypokalemia (K < 3.5), such as in patients with diabetic ketoacidosis and those in life-threatening situations.

The appropriate site selection involves essentially any area where skin and subcutaneous tissue can be pinched. Optimally, between the scapula is the preferred site for children for several reasons: (1) “out of site, out of mind”; (2) it provides a more diffuse subcutaneous area than other locations for fluid to disperse; (3) a parent can hug or hold the child during insertion; (4) there is no need for restraints; and (5) the area is less sensitive to pain than other areas. The skin should be cleansed according to the institution’s policy for parenteral therapy. The use of an insertion device such as a 25-gauge butterfly needle or a 24-gauge catheter is preferred because there is less pain with the smaller gauge needles. The insertion device and/or connection tubing should be gently flushed with 1 mL (150 units) of hyaluronidase. With the skin and subcutaneous tissue pinched, one should insert the needle quickly into the pinched skin at a 20- to 30-degree angle and check for blood return. If a blood return occurs, the needle...
should be removed and another site selected, because direct contact with blood will inactivate the enzyme.

Next, one should push the hyaluronidase into the subcutaneous area and connect the tubing according to the institution policy for parenteral therapy. If a mechanical pump device is being used for fluid delivery, the infusion should be started slowly at first (eg, 50 mL per hour for 5 minutes, then 100 mL per hour for the next 5 minutes, and then at full bolus rate roughly 15 minutes after the insertion). If gravity is used, the roller clamp should be positioned so that full flow of fluid is allowed. Infusion by gravity will be slow at first. The hyaluronidase generally takes about 15 minutes to break down enough of the hyaluronan to create a less dense space for the infiltrating fluid. The fluid selection for infusion should be isotonic (containing normal saline solution [NS] or lactated Ringer’s solution [LR]) because hypotonic and hypertonic solutions may affect the osmotic gradient. One should label the line to notify others that access is subcutaneous, not intravenous.

**ED Nurses’ Questions**

1. Will I lose my intravenous line insertion skills?
   
   **Answer:** No, you won’t lose these skills. Some children and adults will always need IVT. In fact, a bolus of fluids delivered subcutaneously prior to intravenous line insertion may increase your odds of success in a dehydrated patient by increasing vascular volume.

2. What if I need to obtain blood for test?
   
   **Answer:** A fingerstick (for patients ≥6 months of age) or a heelstick (for patients ≤5 months of age) can give you enough blood for the most basic laboratory tests. A blood sample for a culture must be obtained from a vein, but most nurses are able to obtain venous samples for labora-

tory tests. Difficulty usually occurs with cannulation of the vessel.

3. Can I use a larger needle or catheter?
   
   **Answer:** Although you can use a larger needle or catheter, it is not necessary and not recommended. In an adult trial, nearly half a liter of fluid infused in less than 1 hour by gravity through a 24-gauge catheter. Fluid absorption is dependent on the osmotic gradient, not the amount or rate of fluid infusion. In fact, a larger needle may cause more pain because it facilitates more rapid fluid infusion into the subcutaneous space and increased stretching of the dermis.

4. Does it matter which way the needle or catheter is pointed?
   
   **Answer:** It does not matter which way the needle or catheter is pointed, because the flow of fluid is dependent on the dispersion of the enzyme and the absorption of fluid into the vessel. Fluid is not being delivered directly into the vessel where turbulence could occur if fluid infuses against
the natural direction of the flow. However, if the needle or catheter is pointed away from the head, especially in an extremity, gravity will play a role in producing more noticeable edema in the dependent position. The recommendation would be to position the needle or catheter cephalad (toward the head), but it is not necessary.

5. Is the dark pink color around the site an allergic reaction?
   **Answer:** The dark pink color around the site is not an allergic reaction. For reasons not well understood, a dark pink color may evolve around the site, but it is harmless. Generally no tenderness, pruritus, or warmth are noted in the area (Figure 1).

6. How much swelling is expected?
   **Answer:** Swelling will be noticeable during and just after a fluid bolus (Figure 2), but it is soft and painless, unlike a traditional infiltrate. Once the bolus is completed and a maintenance rate is initiated, the swelling will significantly decrease during the next 1 to 2 hours as the remaining fluid is absorbed.

   If infusing the fluid into an extremity, it is wise to document the circumference of the extremity just after the bolus is administered. Should there be a question about whether the fluid is being absorbed, the circumference should be measured again; it should never be greater than the circumference after the bolus. If the area between the scapula is used (Figure 3) and the child begins to complain or acts as if he or she is in pain, or if the site is becoming indurated (firm) and tender, consider administering an additional dose of hyaluronidase. Certain medications may enhance the remanufacturing of hyaluronan, and some children naturally remanufacture the hyaluronan more frequently than every 24 hours. Furthermore, if more than 1 to 1.5 L of fluid have infused into the site, an additional dose of hyaluronidase may be needed.

7. What if the child pulls it out?
   **Answer:** If the hyaluronidase has been infused, initiate a new needle or catheter into the area near the original insertion site. There is no need to reinject hyaluronidase; however, if a new site is chosen, a dose of human recombinant hyaluronidase will need to be given.

8. Can you give medications through a subcutaneous line?
   **Answer:** Technically, any medication that has been approved for use subcutaneously may be given via this route; however, peak plasma times may be different because original times were based on hyaluronan being present. Currently, there is a published study on morphine pharmacokinetics and ceftriaxone pharmacokinetics using hyaluronidase as an adjuvant for medication administration when given SC. More studies are needed for other medications regarding the change in SC pharmacokinetics when hyaluronidase is used.

9. How long can you leave a subcutaneous line in?
   **Answer:** Anecdotally, the longest time that a subcutaneous line has been reported to be left in a patient has been about 48 hours (when the child was discharged from the inpatient unit). Reports of leaving a subcutaneous line in geriatric patients for longer periods have been published. In one study, the average duration of infusion was 15.9 days, with an average daily volume of 1161 mL per day.

10. Can fluids other than NS or LR be administered?
    **Answer:** Yes, fluids other than NS or LR can be administered. Any fluid that contains NS or LR is acceptable (eg, D5 1/2NS with 20 mEq/KCL). Fluid such as D5W is too hypotonic and may affect the sodium-potassium pump mechanism (the osmolarity) that is essential for diffusion to occur. The ability of the fluid to go from an area of high concentration to low concentration will be shifted in reverse so that fluid is actually drawn out of the vascular space and into the subcutaneous space, which is the opposite effect of what is desired.

### Answering Parents’ Questions

1. How does this work?
   **Answer:** People replace their fat (also known as subcutaneous tissue) every 24 hours. A person’s fat is naturally broken down by an enzyme called hyaluronidase before it is replaced. By giving a small amount of this enzyme in an area of fat, the fat basically melts away temporarily. When fluid fills the space that was once fat, it naturally absorbs into the blood vessels.

2. Does it hurt?
   **Answer:** Nerve endings are in the middle layer of the skin, which is pierced. Nerve fibers that run along the blood vessels make intravenous lines hurt more with insertion. With this method, the skin is pierced but the needle goes into the fat (subcutaneous tissue) where there are few

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**TABLE**

<table>
<thead>
<tr>
<th>Key ways SCRT is different from IVT</th>
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<tbody>
<tr>
<td>• Small-gauge catheter or butterfly needle (24- or 25-gauge) preferred</td>
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<tr>
<td>• Needle direction is not critical</td>
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<tr>
<td>• (Soft) swelling is expected</td>
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<tr>
<td>• Loose tape and less tape is better</td>
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<tr>
<td>• Restraints are not necessary (ie, arm boards)</td>
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IVT, Intravenous therapy; SCRT, subcutaneous rehydration therapy.
or no nerve endings. Because we use a very small needle, the pain is with the pierce of the skin (which feels like a finger prick), but it is gone quickly. A topical anesthetic may be used to take away this pain.

In addition, it takes about 15 minutes for the enzyme to reach its full effect, so some children experience a stretching of the skin (which has the nerve endings) until the fat is broken down. They may complain of itching, burning, or some pain initially. However, gradually increasing the fluid rate, putting tape on loosely, and not using much tape seems to minimize any discomfort that may be experienced.

3. What if you don’t get it on the first try?
   Answer: Anywhere we can pinch skin and fat is a potential site for subcutaneous infusion of fluids, unlike an intravenous line, which generally is accessible only in the arms, legs, and scalp (for infants). Unlike in the insertion of an intravenous line, little skill is involved in this procedure, so there is virtually a 100% success rate.

4. Do we have to hold him down?
   Answer: You do not have to hold your child down, but you are welcome to hold him. Restraining techniques and arm boards are not needed.

5. (On discharge) What if we get him home and he vomits or has diarrhea again?
   Answer: He will continue to receive fluid for the next 1 to 2 hours as the remaining fluid under the skin continues to be absorbed. Let his stomach and intestines rest and encourage him to drink small amounts of fluid at frequent intervals in a few hours.

Summary

In summary, hyaluronidase augmented SCRT is becoming an accepted alternative for children with mild to moderate dehydration when ORT has failed and intravenous access is difficult. While use of a nasogastric tube is an accepted alternative, this technique is invasive and usually requires restraining of the child’s extremities and can lead to complications. The use of oral ondansetron has enhanced ORT, but it is not always successful.11 Hyaluronidase augmented SCRT has provided an additional alternative for parenteral therapy, but knowledge of its indications and expectations for use is required. This article provides the ED nurse with some clinical knowledge of hyaluronidase augmented SCRT and its key differences from IVT (Table). Further study of nursing considerations with this method of parenteral therapy in children is strongly recommended.

REFERENCES


