Chapter 8
External Cooling

The PIB

In the past, external cooling of suspension patients has been undertaken using Zip-Loc plastic bags containing crushed or small cubed ice. This approach had the obvious advantage of being simple, straightforward to implement, and very inexpensive.

Unfortunately, years of actual field experience with this approach have disclosed a number of serious limitations and problems:

1) Heat exchange is greatly attenuated by both the insulating properties of the plastic layer and the reduction of convective transfer due to containment of the ice water generated as a result of the ice melting.

2) It is difficult to properly and completely pack the patient in ice, since the ice bags are constantly falling off the patient/cot not staying properly positioned and in good contact with the patient's skin. Keeping ice bags around the head and neck is a particular problem.

3) It is virtually impossible to get ice packs *under* the patient, which means that

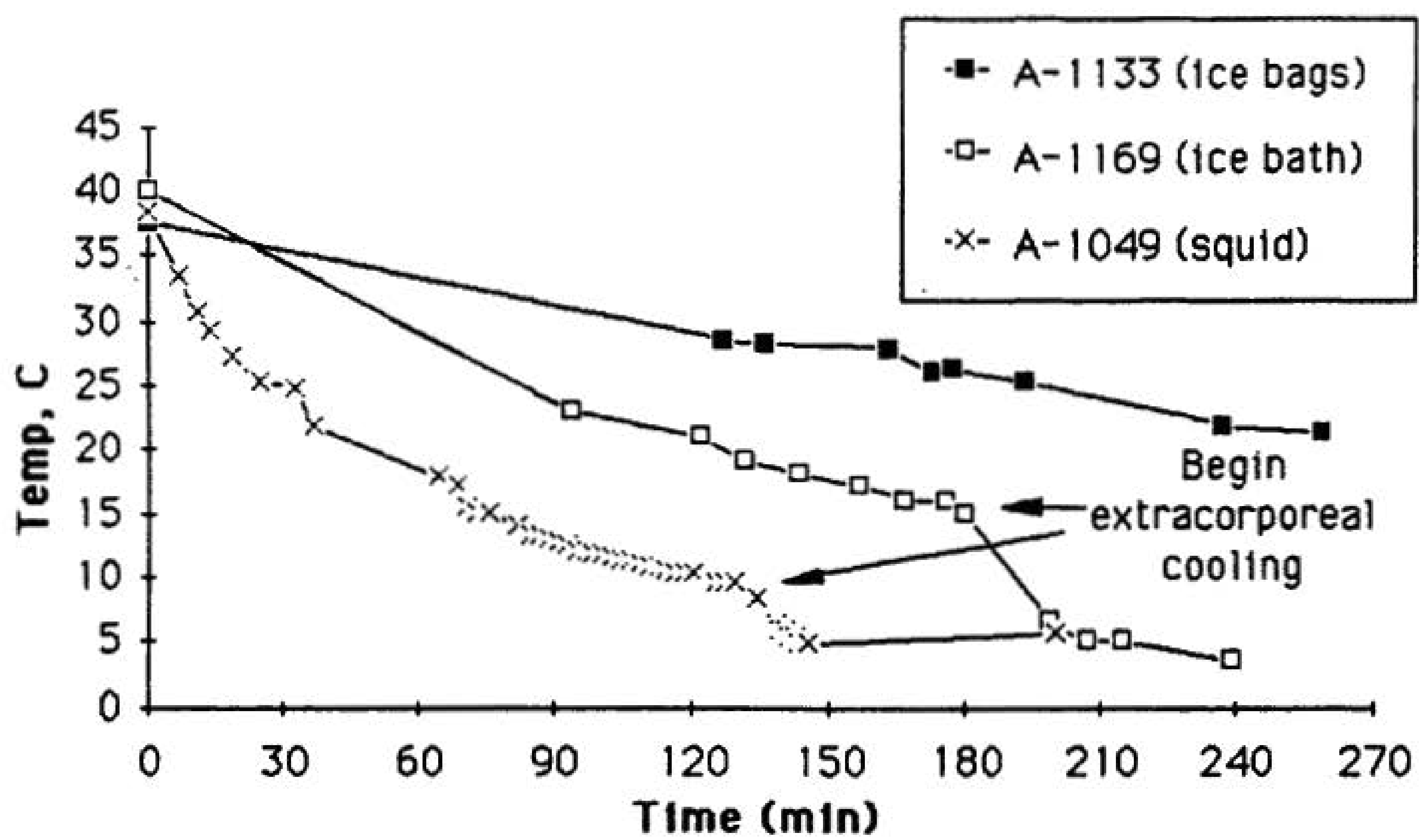
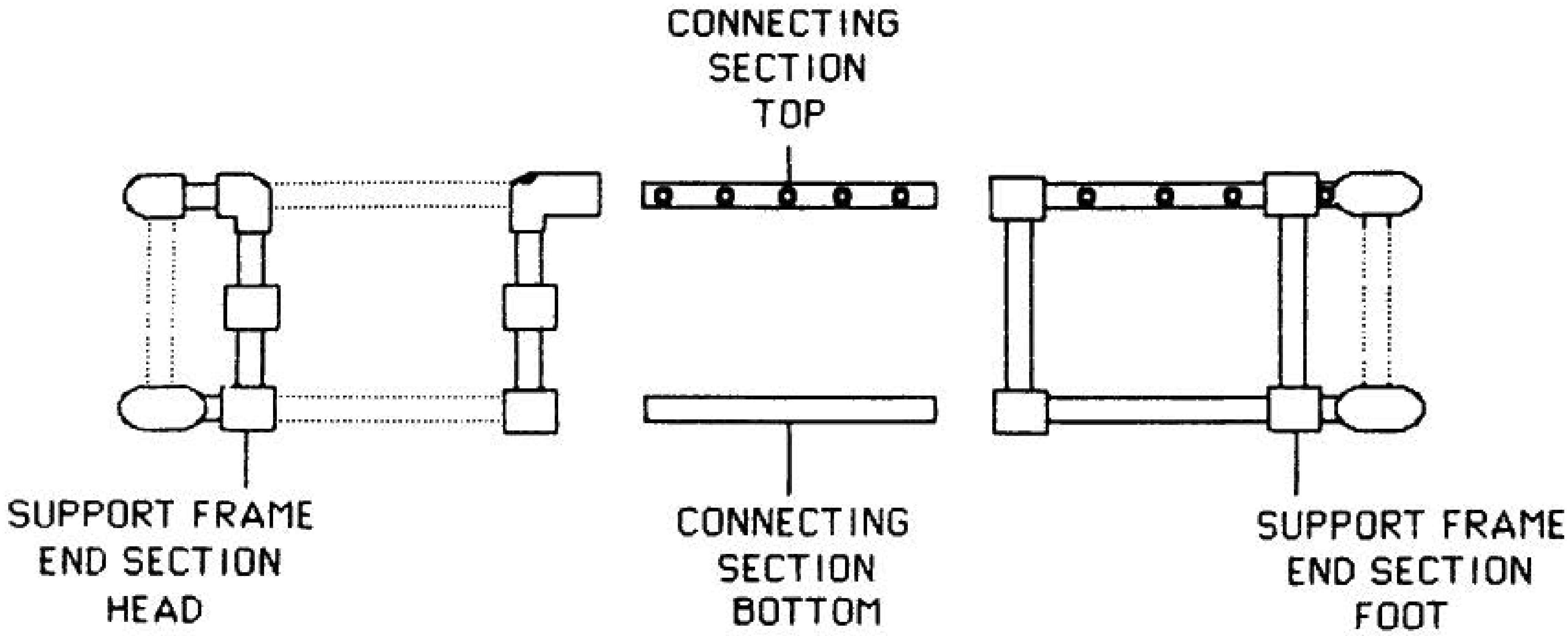
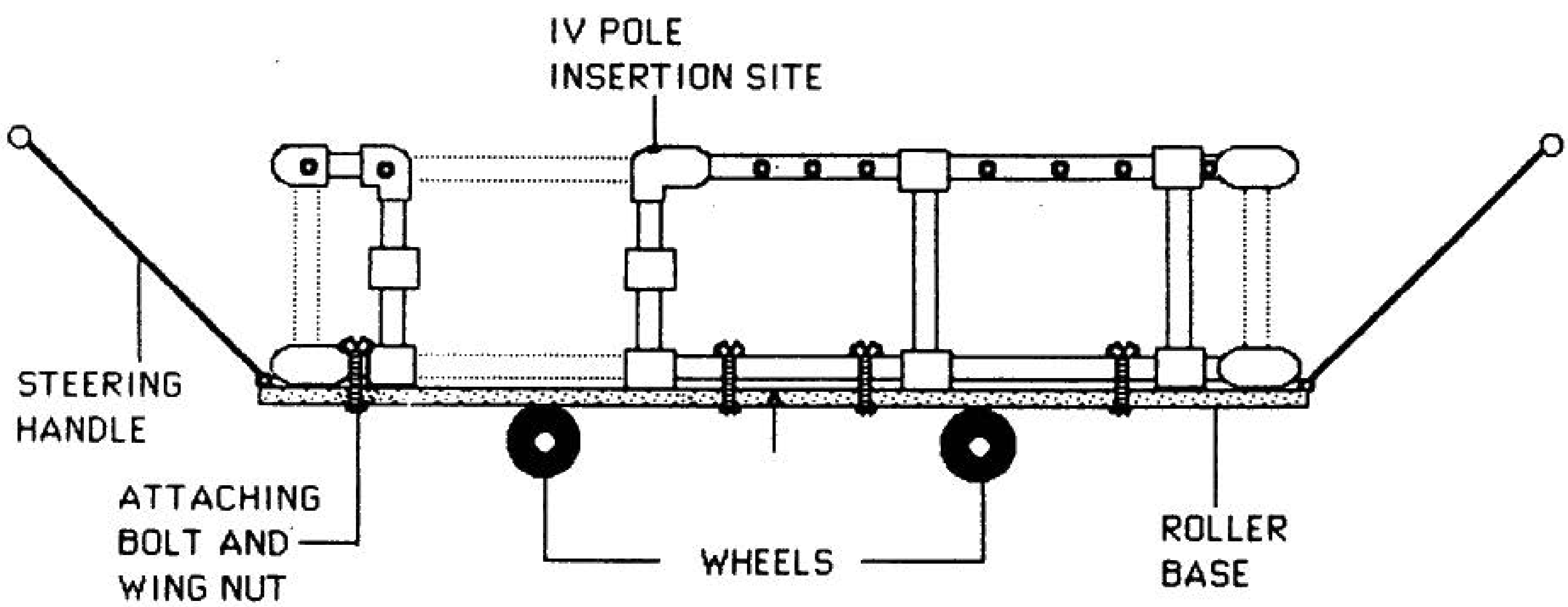


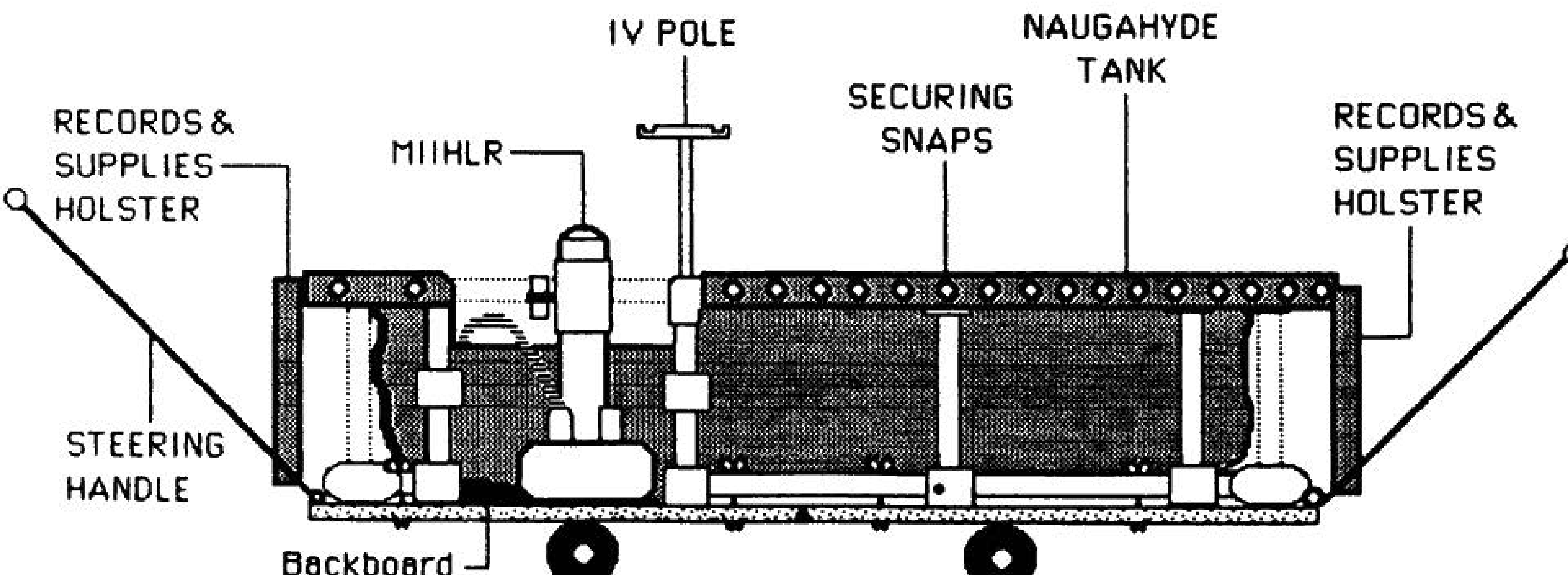
Figure 6A-1: *Actual cooling curves for three adult patients on HLR support, using ice bags, portable ice bath (PIB), and PIB plus SQUID cooling. Patient A-1133 weighed 56.8 kg, patient A-1169 weighed 57.3 kg, and patient A-1049 weighed 36.4 kg. As this data indicates, PIB cooling is approximately twice as effective as ice bag cooling. The SQUID increases the rate of cooling by yet another 50% over the PIB (roughly adjusting for differences in patient's weights).*



The components of the PVC frame of the Portable Ice Bath.



The frame of the PIB attached to the baseplate.



The PIB with the tank and Michigan Instruments HLR mounted.

Figure 8-1: *Elements of the Portable Ice Bath.*

35% to 45% of the patient's surface area is unavailable for heat exchange.

4) Bags leak and sweat, causing water to wet the patient and drip off the cot or gurney during transport. This presents both an immediate safety hazard (creating slippery floors and a potential electrical hazard) *and also serves to contaminate staff and the working environment with potentially infectious fluids.*

For these reasons a lightweight, inexpensive, *Portable Ice Bath* (PIB) was developed. The purpose of the PIB was to simulate the kind of conditions normally encountered in cases of ice water drowning where very high rates of heat exchange are known to occur. *Indeed, in such cases of cold water drowning, it is often possible to successfully resuscitate people who have simply been chilled in the absence of any cardiopulmonary support for up to 30 minutes.*

The PIB consists of a waterproof Naugahyde tank, which snaps to a rigid frame of 1-1/4" OD PVC plastic pipe. The PIB may be broken down into easy-to-transport elements: two end sections measuring roughly 25" x 26" x 13", four connecting sections of pipe, each of which is 21" long, a roller base of heavy plywood, the snap-on Naugahyde tank, and a Naugahyde "privacy cover". The PIB can be assembled by one man in approximately 10 minutes. The lightweight plastic construction means that it can be easily transported prior to and during its use on the patient. The PIB is designed to be transported independent of an ambulance cot.

Each PIB is a "custom" unit; they were all made slightly different from each other. Thus, parts from one PIB *cannot be interchanged with parts from another.* The components of each tank have been marked with an identifying number, as well as the orientation of each part required to assemble it (i.e., head, foot, left, right, etc.).

Assembly Of The PIB

The PIB may be assembled using the following procedure:

1) Unfold the **Roller Base** and lay out the components of the PIB in an organized fashion and make sure they are all there:

Quantity	Item
1	Head End Section
1	Foot End Section
2	Top Connecting Section (with upholstery snaps)
2	Bottom Connecting Section (with bolt holes)
8	Attaching Bolts with Wing Nuts
8	Securing Screws with Wing Nuts
2	Steering Handles (usually already attached to the base)
1	Naugahyde Tank with Privacy Cover
1	Records & Supplies Holster (at foot)
1	Brunswick HLR Holster (at head)
1	POP Holder (and Meds Tray)

2) Using the **Attaching Bolts** (with the wing nuts on top), loosely attach the two **Bottom Connecting Sections** to the **Roller Base**. The components are marked "left" and "right", "head" and "foot", and should be so oriented.

3) Slip the **Foot End Section** onto the **Bottom Connecting Sections** in the indicated orientation.

4) Attach the two **Top Connecting Sections** to the **Foot End Sections** in the proper orientation.

5) Attach the **Foot End Section** to the **Roller Base** with the **Attaching Bolts** with the wing nuts on top, loosely.

6) Slip the **Head End Section** on the **Connecting Sections.**

7) Attach the **Head End Section** and the **Bottom Connecting Sections** to the **Roller Base** with the **Attaching Bolts**, with the wing nuts on top.

8) Tighten all the wing nuts.

9) Insert the **IV Pole** into the hole in the PVC tubing of the **Side Section.**

10) Attach the **Naugahyde Tank** and **Holsters** to the **Support Frame.**

11) Slip the **Steering Handles** into the hinges on the **Roller Base**, if not already done. The larger **Steering Handle** goes on the head end and the smaller one on the foot end. (The PIB is usually shipped with the **Steering Handles** in place.)

12) Place the POP Holder over the lower 1/4th of the top of the PIP and rest the Portable Oxygen Pack (POP) on it.

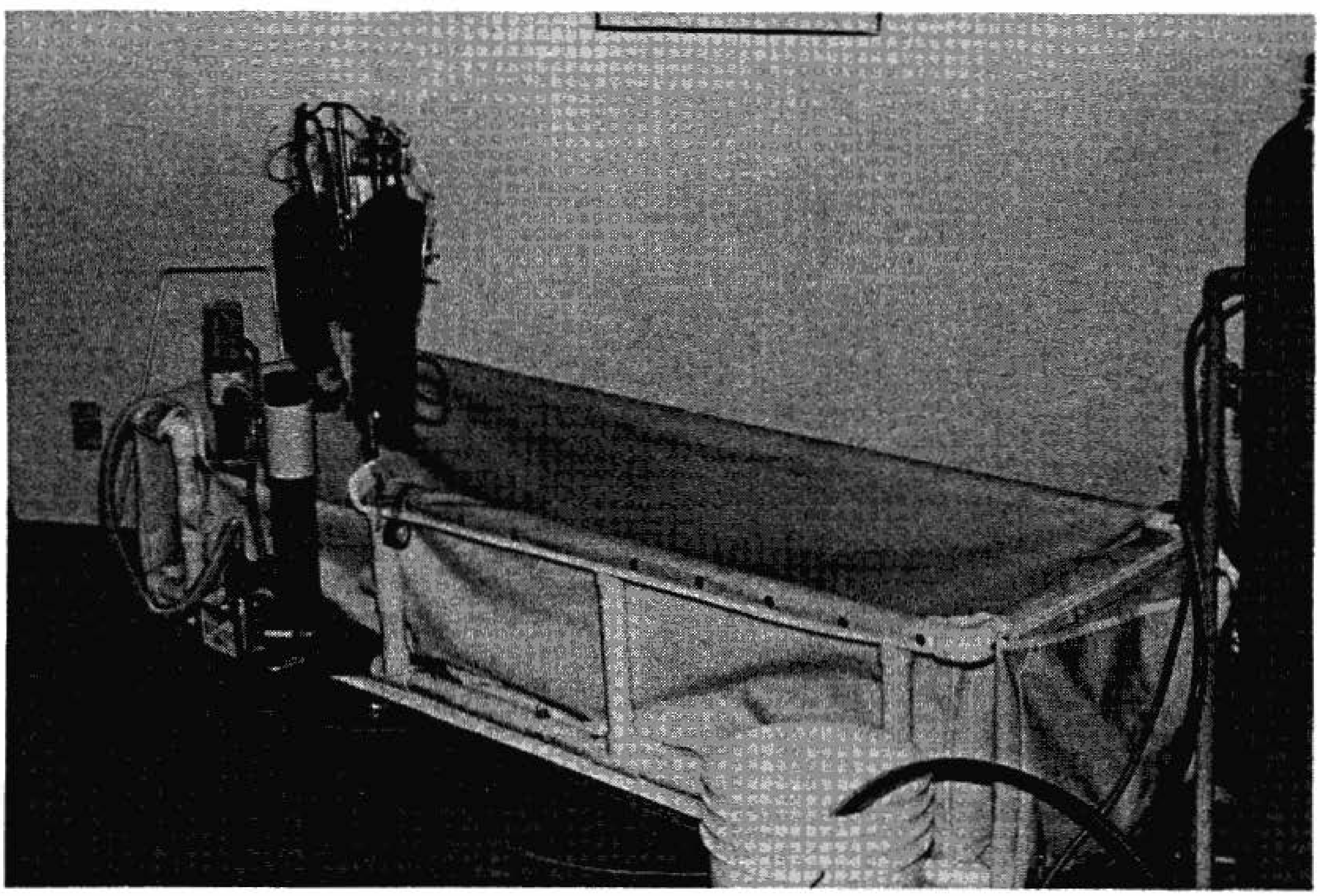


Figure 8-2: *The Portable Ice Bath.*

Initiation Of External Cooling With The PIB

Once cardiopulmonary support has been established, cool the patient externally by packing in ice. The most effective way to do this is to use the PIB, which allows for direct contact of crushed ice with the patient's skin. The PIB may also be used to create an ice/water slush for even more rapid cooling. The PIB using crushed ice in direct contact with the patient's skin *will more than double the rate of cooling that can be achieved with ice contained in plastic bags.* The PIB is many times more effective at reducing patient core temperature than simple air cooling such as is achieved by placing the patient in a refrigerated morgue or "reefer" unit.

Ideally, as soon as legal death is pronounced, the patient should be rapidly transferred to the PIB and connected to the HLR (manual CPR should be used as a bridge between the time legal death is pronounced and the time it takes to organize for transfer of the patient into the PIB). Once the patient is positioned in the PIB and mechanical CPR has been started, the patient should be packed in ice from head to toe. It is recommended that during initial resuscitation, complex and potentially time-consuming procedures such as the initiation of IV therapy be delayed until the patient has been positioned in the PIB. Use of a mask with oropharyngeal airway or the EGTA for ventilation is recommended until the patient is in the PIB.

CAUTION: Do not place ice in the PIB before the patient is transferred into it, as the presence of ice (particularly if an MII-HLR is being used) will make proper application of the HLR impossible. Exercise care to avoid wetting the piston of MII-HLR units as it will cause the piston to "lock-up" and the unit to stop cycling!

As soon as legal death is pronounced, remove from the patient all clothing such as hospital gowns, undergarments, or antiembolism stockings. The most expedient and practical way to remove such clothing is to cut it off using bandage scissors or the Superscissors contained in the kit. At this point, any jewelry on the patient should be removed and placed on the transport technician's person for safe-keeping.

The patient's genitals must remain covered at all times during transport and external cooling. The genitals may be covered with a towel or small disposable drape sheet. This is an important gesture of respect and decent treatment, and is not just a courtesy to the patient and personnel who may come in contact with the patient, it is also the law in many states. Failure to offer this respect can result in civil prosecution.

The SQUID

One of the principal barriers to effecient external cooling is the existence of so-called "boundry layers" of insulating water which become established around the patient in the PIB. Anyone who has ever been on a camping trip and had the frustrating experience of trying to melt snow for drinking water will immediately understand this phenomenon; in the center of the kettle will be a mass of snow surrounded by tepid water while the water near the wall of the pot is *boiling*. Only by vigorous stirring can one break up such boundry layers and achieve effecient heat exchange.

Recently, Fred Chamberlain, one of the founders of Alcor, decided to attack this problem with respect to the cooling of patients in the PIB. His solution to the boundry layer problem was the development of a circulating pump and ice water distribution assembly that can be used in the PIB.

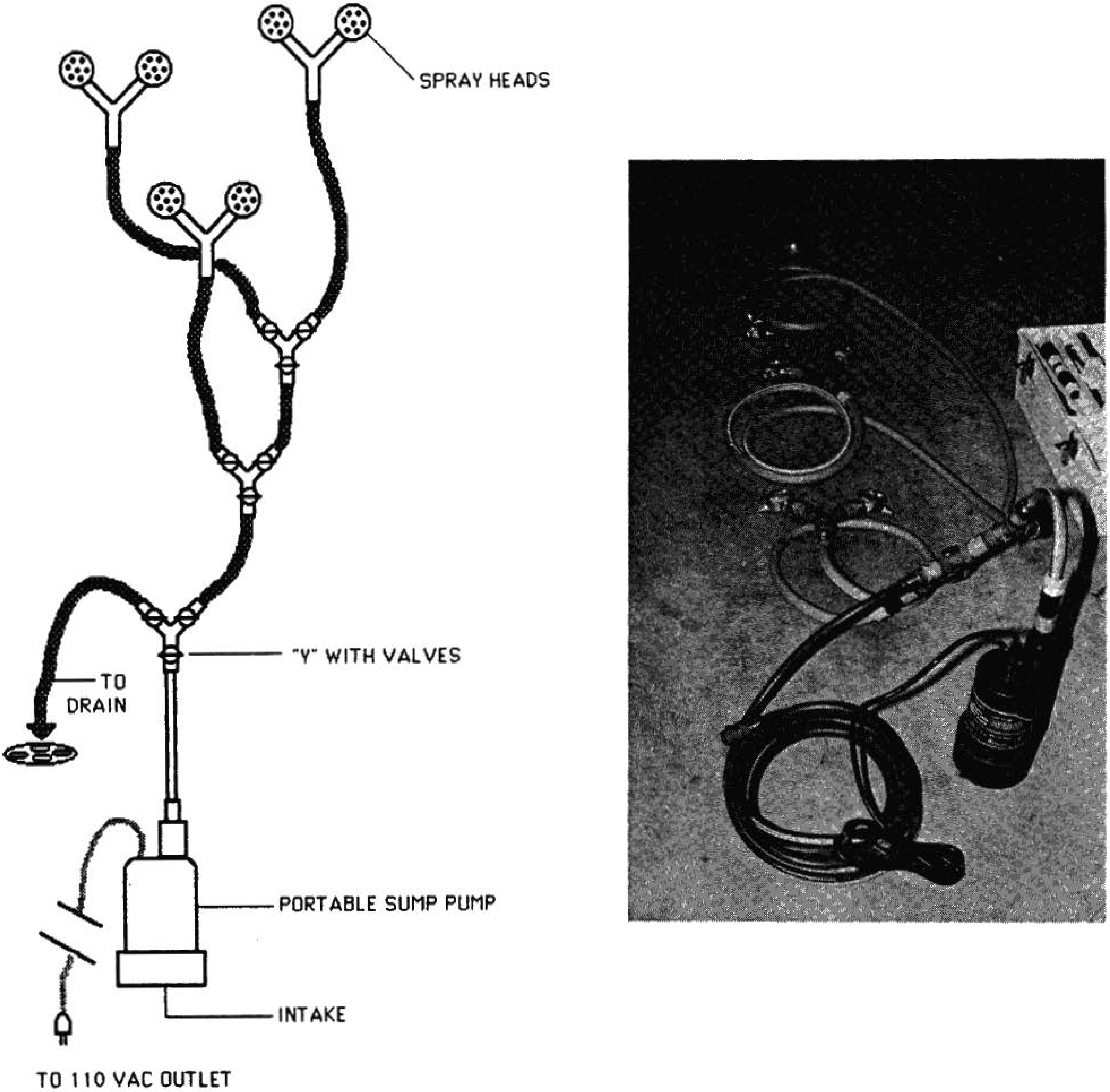


Figure 8-4: *The SQUID*

This device, known as the SQUID, consists of a 40 GPM output, lightweight submersible sump pump, connected to a manifold of garden hosing and small lawn sprinkler heads, as shown in *Figure 8-4*. The hosing and sprinkler heads--using quick disconnects--snap rapidly into any desired configuration. Sprinkler heads may be positioned so that a fast moving stream of ice cold water can be directed over the patient's head, as well as to other key heat exchange areas, such as the axilla and groin.

Use Of The SQUID

The SQUID is simple in design and extremely easy to apply. Once the patient is in the PIB and packed in ice, add enough water to the PIB to fill it to a depth of at least 2" to 3". Position the SQUID pump inside the PIP at the foot end, either between the patient's feet or to one side of them as per *Figure 8-5* below.

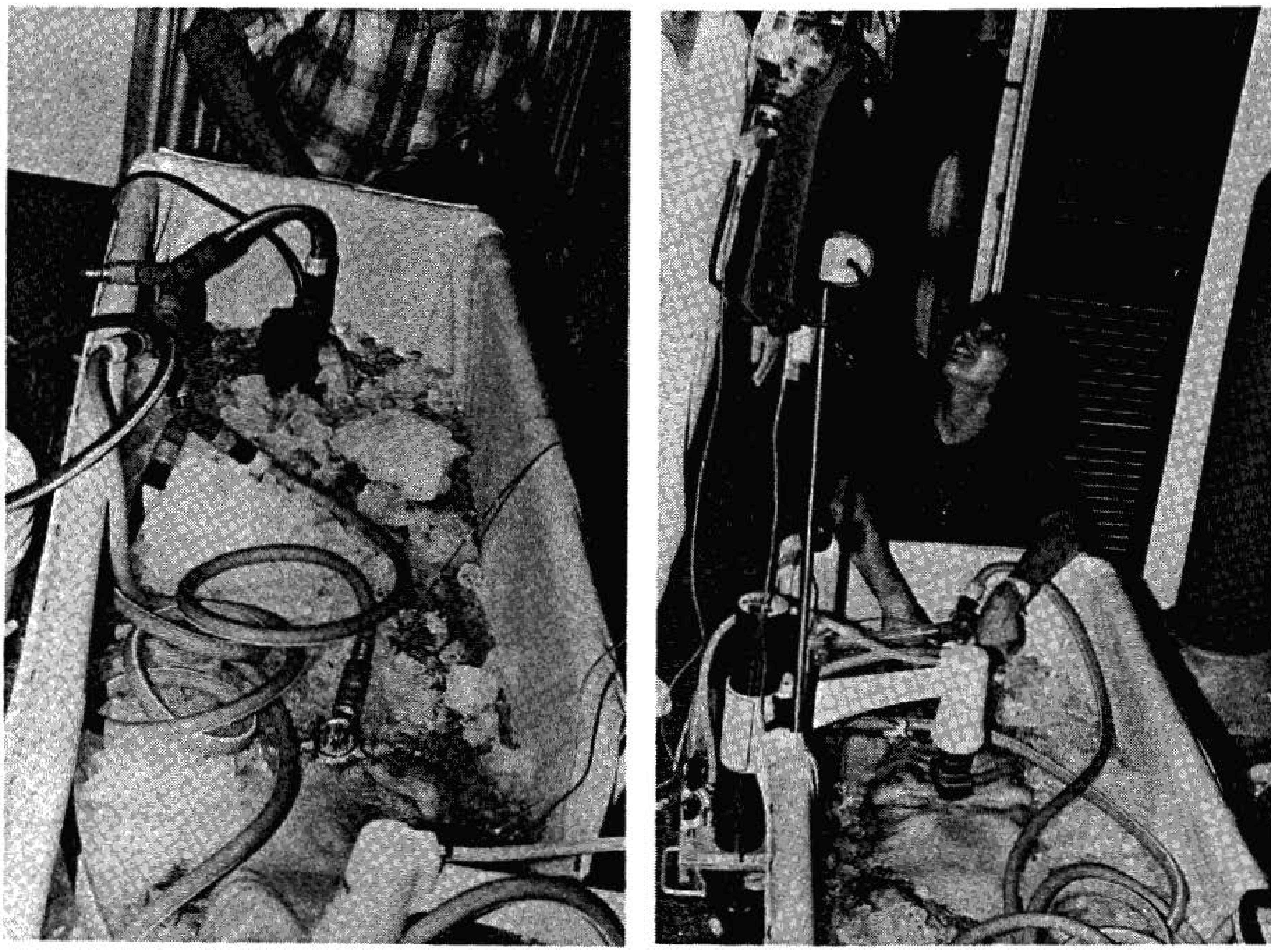


Figure 8-5: *Two views of the SQUID in use.*

Snap the distribution tubing onto the pump and position the sprinkler heads as appropriate. A recommended pattern of positioning is:

1) 2 sprinklers at the head.

2) 2 sprinklers at the neck.

3) 2 sprinklers at the groin.

4) 1 sprinkler at each axilla.

The principal drawback to the SQUID in its current form is that it is dependant upon electric power to operate. This limits its usefulness in transit, unless there is 110 V AC power available in the transporting vehicle.

Nevertheless, the SQUID may still be very useful, particularly in situations where medications are to be administered before vehicular transport, as this typically takes 45 minutes to an hour to do. There will also be many situations where transportation (local mortician, ambulance, etc.) must be summoned after the start of external cooling and where there is likely to be a delay of 15 to 30 minutes before transporation arrives. **Keep in mind that the SQUID, when used in conjunction with the PIB, can decrease a thin patient's temperature as much as 12°C in 30 minutes.** Thus, every minute that the SQUID *can* be used, it *should* be used.

If use of the SQUID has to be interrupted, restart it as soon as possible.

Ice Bag Method

If the PIB is unavailable, pack the patient in crushed ice contained in high quality Zip-Loc plastic bags (See *Figure 8-3*). (Those manufactured by the Dow Chemical Company are preferred.) Leaking bags present a serious safety hazard in the form of water on the floor, and an electrical hazard if the patient is in an electrically operated bed. Special attention should be paid to packing the head, neck, axilla (armpits), and groin in ice, since large vessels which carry a significant fraction of the cardiac output lie close to the skin in these areas, and are thus available for heat exchange.

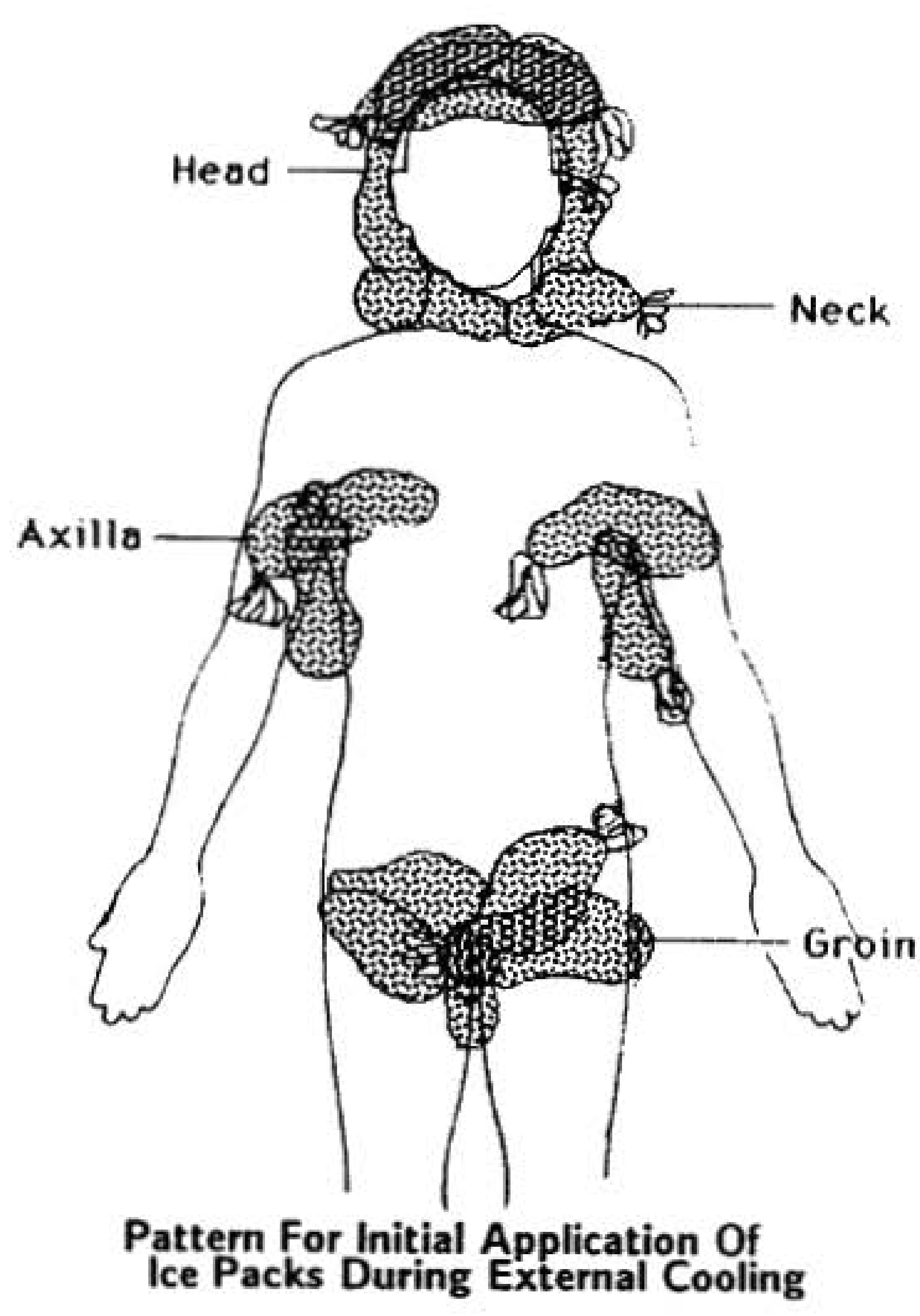


Figure 8-3: *Ice Packing.*