Epidural Cooling for Spinal Cord Protection During Thoracoabdominal Aortic Aneurysm Repair

(A Case Study)

By Christine Downey, RN, BScN, CPN(C)

Abstract

Aneurysms result from damage to artery walls as a result of underlying athrosclerotic and /or thromboembolic disorders. A thoracoabdominal aortic aneurysm involves vessel damage and wall weakening in the thoracic and abdominal segments of the aorta.

Thoracoabdominal aortic aneurysm repair is considered to be high risk due to the nature of the intervention that requires an extensive incision with clamping of the thoracic aorta above the renal arteries. Clamping of the aorta renders all areas distal to the clamp at high risk for ischemic trauma especially to the spinal cord where the risk of neurological deficits postoperatively is 7 - 16 % (Cambria, et al., 1997; Davison, et al., 1 997).

Several adjunct interventions have been tried to reduce the risk of spinal cord injury associated with the ischemia of cross clamping. Epidural cooling has been successful as an adjunct in reducing the neurological deficits.

A preoperative nursing assessment indicating the appropriate nursing diagnoses and nursing care required for this patient, allowed for individualization of the plan needed to include this new procedure and plan for best patient outcomes and practices.

Statement of the Problem

Aneurysms result from damage to artery walls as a result of underlying athrosclerotic and /or thromboembolic disorders. There are four distinct types of aneurysms described in the literature. A fusiform aneurysm is "a uniform, spindle shaped dilatation" of a segment of the artery; a saccular aneurysm is an "outpouching of the artery caused by stretching of the media layer"; a dissecting aneurysm is described as "a cavity formed by blood that has been forced between the layers" of the artery, and a false aneurysm is one "resulting from a complete rupture or wounding of all coats of the artery, the blood being retained by the surrounding tissues" (Luckman & Sorensen, 1974). The aneurysmal sac expands over time and the patient usually remains asymptomatic unless the aneurysm is large and begins to dissect and rupture. A thoracoabdominal aortic aneurysm, as the name suggests, involves vessel damage and wall weakening in the thoracic and abdominal segments of the aorta.

In 1990, E.Stanley Crawford classified thoracoabdominal aortic aneurysms into four types:

"**Type I** - most or all of the descending thoracic and upper abdominal aorta including the visceral branches;

Type II - most of the descending thoracic and abdominal aortic segments;

Type III - less than half of the descending thoracic aorta and varying segments of the abdominal

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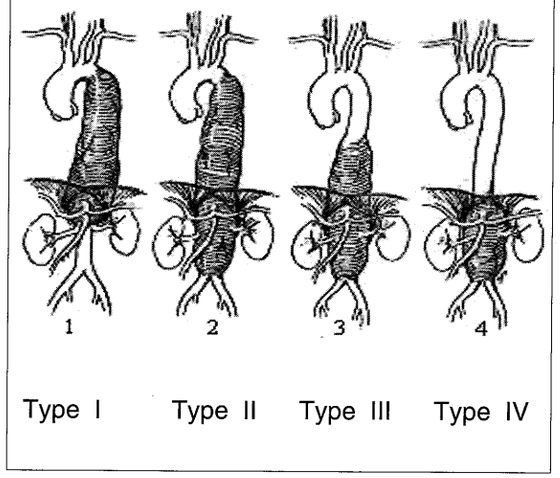
aorta including the visceral origins; and

Type IV - confined to the abdominal aorta and involved the proximal segment from which the visceral vessels arose and varying segments up to and including all the lower abdominal aorta. (See Figure 1)

The best outcomes for patients diagnosed with thoracoabdominal aortic aneurysm are achieved when the aneurysm is identified before it becomes too large (> 6-8 cm) and the aorta can be surgically reconstructed under optimal controlled conditions (Crawford, 1990). What are the risks involved if thoracoabdominal aneurysms go untreated? Untreated patients may die within 5 years of diagnosis with 25% alive after two years. Indeed, 52% of the mortality rate for these patients is due to rupture (Crawford, 1990). However, treatment consisting of elective, controlled surgical repair with a prosthetic graft, increases the survival rate at 5 years to 60%, and at 10 years to 32% (Crawford).

Thoracoabdominal aortic aneurysm repair is considered to be high risk due to the nature of the intervention that requires an extensive incision with clamping of the thoracic aorta above the renal arteries. Clamping of the aorta results in occlusion and renders all areas distal to the clamp at high risk for ischemic trauma. This is especially true for areas such as the spinal cord, the kidneys and the abdominal viscera that have little tolerance for ischemia.

Figure 1



Review of The Literature

A review of the literature revealed tissue ischemia to be the number one risk associated with thoracoabdominal aneurysm repair due to aortic cross clamping, dissection, and/or rupture (Svensson et al., 1998; Cambria et al., 1996; Grabitz et al., 1996; Crawford, 1990). Spinal cord injury from ischemia was the second highest risk identified ranging from 7-16% manifesting as paraplegia, and paraparesis, especially in the lower limbs (Cambria et al, 1997; Crawford, 1990, Davison, 1994). Renal failure from ischemia, follows at 10 % and manifests as acute tubular necrosis (Cambria et al., Grabitz et al.,)

Several adjunct interventions have been tried to reduce the risk of spinal cord injury associated with the ischemia of cross clamping by reducing the oxygen requirements of the spinal cord. Maintenance of Cerebrospinal fluid (CSF) pressure at < or equal to 15mmHg by draining the excess was thought to protect the spinal cord during cross clamping (Murray et al.,1993). CSF Drainage with Distal Aortic Perfusion (DAP) were interventions performed in a study by Safi et al. (1996). The results of this study indicated a statistically significant reduction (p= 0.033) in the incidence of neurological deficits for patients with Type I and II Thoracoabdominal Aneurysms. Intrathecal Papaverine with CSF Drainage and Intrathecal Cooling was tried with porcine models in a study conducted by Sun et al.(1998). They found the use of papaverine to dilate the spinal arteries in conjunction with intrathecal cooling, and CSF drainage appeared to extend the period of safe aortic cross clamping. Epidural Cooling which runs a solution of cold isotonic saline through the epidural space to maintain the CSF at a mean temperature of 24 C (+/ -3 degrees) has been successful as an adjunct in reducing the neurological deficits attributed to aortic cross clamping. (Cambria et al., 1997; Davison et al., 1994).

Epidural Cooling - A New Intervention

Kingston General Hospital is a tertiary care hospital located in Kingston, Ontario and is associated with Queen's University. It serves the public by providing many services, such as vascular surgery, neurosurgery and cardiac surgery, that are usually found in larger centres such as Toronto, Ottawa and Montreal.

The Vascular Department routinely performs abdominal aortic aneurysm repairs, and aortic bifemoral grafting procedures, but opportunity to intervene with thoracoabdominal aneurysms is not routine, and epidural cooling of the spinal cord as an adjunct intervention had never been tried here before. In September 1999, a decision to perform this intervention on a selected patient was made by the head of the department of vascular surgery and a member of the department of anesthesiology. This was the first time epidural cooling had been tried here, and the opportunity to be part of this new intervention was not to be missed.

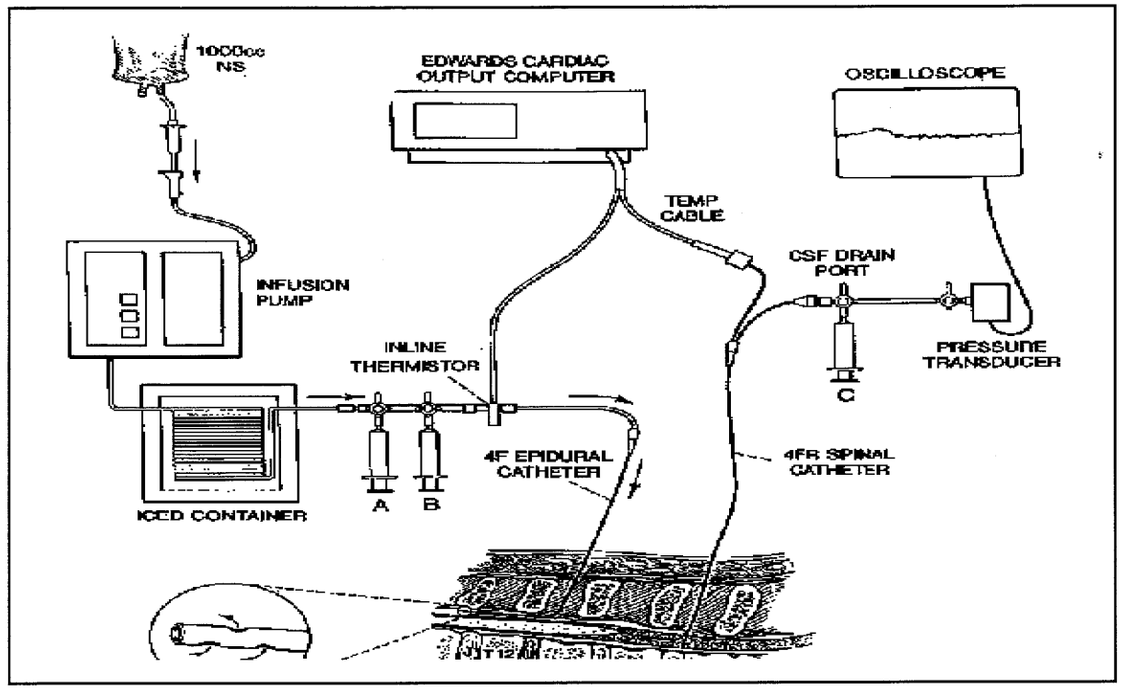


Figure 2

Anesthetic Procedure

On arrival in the OR theatre, the patient was positioned supine on the OR table and attached to a non-invasive blood pressure cuff, a cardiac monitor using five leads, and an oxygen saturation monitor. At this point, the patient was assisted to a sitting position with the monitoring devices in place on the OR table.

The epidural cooling protocol had not been performed in our hospital before so the protocol followed by the members of our anesthesia team, with some slight modifications, was the same as that used at the Massachusetts General Hospital, Harvard Medical School (Davison et al., 1994).

Under aseptic conditions an epidural needle was inserted in a cephalad direction at the T12-Ll level. The catheter was flushed with saline to assure patency and tested for blood aspiration to determine appropriate positioning. Next, a 4 Fr. Pediatric Swan Ganz catheter was inserted in a cephalad direction at the L3-L4 level. Both catheters were secured on the patient's back with dressing strips at the catheter site, and tape applied from the catheter site to the shoulder. The Anesthetic team declined to test the cooling apparatus using the iced saline solution that was suggested by the initial investigators of this procedure, as this has been shown to be quite painful. They did inject the epidural catheter prior to induction, with a solution of 2% Lidocaine and epinephrine and the patient's sensory levels were checked. The epidural catheter and the spinal catheter were then connected to a closed system for cooling and monitoring of an isotonic saline solution to be kept at between 6 and 10 C that would be flushed through the epidural space. (See Figure 2)

The patient was then placed back into a supine position paying particular attention the epidural and spinal lines remaining secured and unkinked during the repositioning. The anesthetic team then established further venous access with two more peripheral lines using 18g angiocaths, and a Cordis inserted into the right internal jugular. Accurate hemodynamic monitoring was established with a right radial arterial line. The patient underwent anesthetic induction using intravenous *Propofol* and a double lumen endotracheal tube was inserted into the airway. Post anesthetic induction, the patient was placed in the right lateral "thoracoabdominal" position. (Figure 3)

Surgical Intervention

The patient was prepped with 10% Povidone-iodine solution and square draped in the usual manner. A thoracoabdominal incision was made with the patient in the "thoracoabdominal" position. A left paramedian incision was made extending across the costal margin of the fifth intercostal space. The left colon and abdominal viscera were mobilized to expose the retropertitoneal aorta. The distal descending thoracic aorta was dissected free for proximal cross clamping, and the left and right external and internal iliac arteries were mobilized. The aorta and iliac arteries were cross clamped. The large infrarenal aneurysm was opened and a large thrombus was removed. A nice anatomical neck was noted at the level of the renal arteries and became the site of the proximal anastomosis.

At this time the patients core temperature was noted, by anesthesia, to be very low 34C. It was felt is would be unsafe to risk idiopathic hypothermic coagulopathies in this patient by continuing to use the spinal cooling infusion given the time factor need to complete the procedure and the infusion was discontinued. A knitted *Gelsoft* bifurcated graft, 20mm x 10mm was anastomosed proximally to the aorta at the level of the renal arteries using 2-0 *Prolene* sutures. The proximal cross clamp was removed and replaced onto the graft to reperfuse the viscera and kidneys. Total renal ischemic time was approximately 17 minutes. Three pair of lumbar arteries were oversewn within the infrarenal aorta . The left limb of the graft was anastomosed to the iliac bifurcation and the right limb of the graft was anastomosed end to end to the external iliac artery The diaphragm was closed and two 32Fr. *Argyle* chest tubes were placed in the chest. The abdomen was dry, the wound was closed and the skin incision was stapled. The wound was dressed with large dressing strips, and the chest tubes were attached to an underwater sealed double chamber drainage system, under 20 cm of H20 pressure. These tubes were then secured to the chest with waterproof tape. The patient remained intubated but stable and was transported to the Intensive Care Unit where she was placed on ventilated support.

Nursing Care Plan

A preoperative nursing assessment was performed the evening prior to surgery indicating the following nursing diagnoses and the perioperative nursing care required for this patient.

Pt. L., a 75 year old female was admitted to hospital

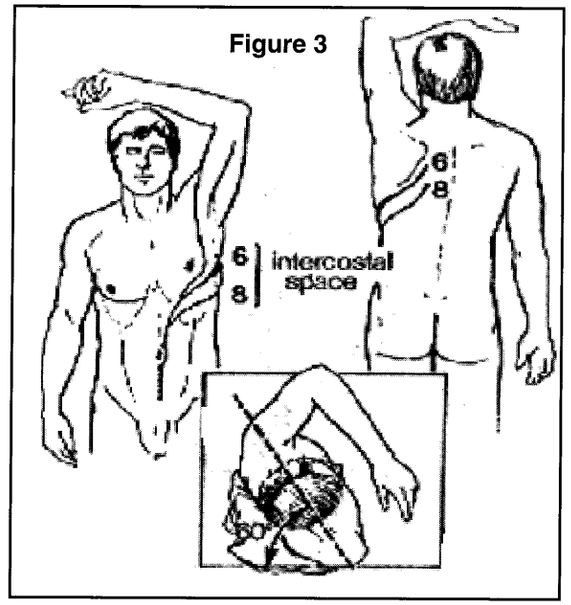


Figure 3

for repair of a descending Type IV Thoracoabdominal aortic aneurysm approximately 8 cm in diameter. In collaboration with Anesthesia, an epidural spinal cooling technique was used to reduce the oxygen requirements of the spinal cord vessels during aortic cross clamping with the intent of decreasing the risk of post operative paraplegia and paraparesis.

Assessment

On admission to hospital, Pt. L.'s vital signs were blood pressure 125/85, heart rate 87, respiratory rate 18, and oral temperature 36.5. Routine medications included: *Prepulsid* 20 mg quid, *Fluoxetine* 40 mg qam, *Vasotec* 20 mg od, *Diltiaz* CD 180 mg od, *Furosemide* 20 mg bid, *Oxazepam* 30 mg qhs, *Levodapal* 100 mg, *Carbidopa* 25mg, *Ventolin* 2 puffs q4h, and *Atrovent* 2 puffs q4h. Admission blood studies indicated a Hgb of 115, Hct 0.347, electrolytes within normal parameters, INR 1.2 seconds, PT 14.0 seconds and PTT 26 seconds.

Pt. L.'s medical history included hypertension, reactive airway disease, Chronic Obstructive Pulmonary Disease (COPD), Parkinson's disease, and anxiety. The patient had had two previous surgeries, an appendectomy and an abdominal hysterectomy.

Pt. L. stated she had no known drug allergies (including iodine), latex allergy, or environmental allergies (including adhesive tape).

Pre admission testing included a chest X-ray, EKG, arteriograms, and computed axial tomography of the thorax and abdomen showing extensive aneurysmal disease (Thoracoabdominal Aortic Aneurysm Type IV- 8 cm in diameter).

Nursing Diagnosis

1) **High risk for Injury** related to positioning of an anesthetized patient in a modified right lateral position exposing the left thorax and both groins.

2) **High risk for Infection** related to impaired circulation; the presence of invasive lines; intubation; and surgical intervention.

3) **High risk for Hypothermia** related to patient's age; exposure to cold solution infused into the epidural space; large thoracoabdominal incision; the length of time required for surgical intervention and the ambient temperature of the operating theatre (19C).

4) **High risk for Electro-surgical Burns** related to the number of invasive lines with the potential to conduct current, and the large thoracoabdominal incision requiring increased use of electrocautery to achieve hemostasis.

5) **Collaborative Problem: Potential Complication : Fluid and Electrolyte Imbalance**

Fluid Imbalance related to increased susceptibility of the elderly to fluid loss and dehydration due to decreased renal blood flow resulting in a decreased Glomerular Filtration Rate; decreased thermoregulation; NPO status preoperatively; and potential for hemorrhage during surgery.

Potential for Hyperkalemia related to transfusions of stored blood.

Planning and Implementation of Care

Goals: To reduce the risks and potential complications associated with Epidural cooling and Thoracoabdominal Aneurysm Repair.

Objectives: l) To maintain the patient in proper body alignment where possible and ensure potential nerve pressure areas are appropriately padded. **2)** To adhere to meticulous aseptic technique for all invasive procedures and surgical interventions. **3)** To ensure careful observation of all electrical and mechanical devices being used for potential problems. **4)** To ensure accurate communications of changes/ problems between all members of the team.

1) High risk for Injury:

The operating table was equipped with a full gel mattress, and a bean bag positioning device. A metal arm holder was in place to support the left arm. Egg crate "booties" were placed on the patient's ankles and knees. Pillows were placed between the patient's legs and feet, and under the right arm. A velcro safety strap was attached across the patient's thighs to secure her position. All electrical and mechanical equipment being used during the procedure were checked preoperatively and assessed to be in working order.

2) High risk for Infection:

All anaesthesia lines were monitored during insertion for breaks in technique. Aseptic technique was meticulously adhered to during the surgical procedure, any accidental breaks in technique such as glove tears would be rectified as soon as possible. Ancef 1 gm. in 250 mls of normal saline was piggybacked to one of the lines in situ.

3) High risk for Hypothermia:

A Blanketrol II thermoregulatory water blanket was placed under the gel mattress with a setpoint of 38 C. Nursing personnel assisted with the placement of the LifeAir 1000 thermoregulatory blanket, set to 100 C over the patient's shoulder and face area. Sewn sponges were used dry during the surgery.

The ambient temperature of the operating theatre was raised to 24 C. The surgical lights were used on their highest setting.

4) High risk for Electro-surgical Burns:

A Valleylab Force 2B electrosurgical unit was used with the Return Electrode Monitoring (REM) pad placed on the medial aspect of the patient's right thigh. The cautery was set to a coagulation power of 30 watts and cutting power of 0.

5) Potential Complication: Fluid and Electrolyte Imbalance:

A foley catheter was inserted and attached to a urimeter for accurate measurement of urine output. An intravenous using an 18 gauge angiocath was in situ in the patient's left forearm with 0.9% NaCl infusing. A 14 gauge angiocath was inserted into the patient's left forearm near the antecubital fossa. A Cordis was inserted into the right internal jugular and an arterial line was inserted in the right radial artery. Careful observation was made of the blood loss throughout the perioperative period both in the suctions and on the discarded sponges. A cell saver was used to collect blood lost at the surgical site and prepared it to be reinfused. Twelve (12) units of packed red blood cells, platelets and fresh frozen plasma were available as requested by the anesthetic and surgical team.

Evaluation

During this procedure the aortic clamp time was minimal at approximately 17 minutes. The epidural infusion was discontinued when the patient's core temperature was noted to be around 34 degrees C in order to reduce the risk of hypothermic coagulopathy postoperatively. The surgical intervention was uneventful and aseptic technique was maintained throughout. There was minimal use of blood products other than those units returned to the patient from the cell saver. There were no problems with the electrical and mechanical devices being used during the surgery. The sponge, needle and miscellaneous counts were correct at closing.

The patient continued to produce urine throughout and was noted to be cool to the touch. At the end of the procedure, the patient was inspected for pressure areas and burn marks. None were noted. The patient was stable and transferred from the OR to the ICU where she was placed on ventilated support.

Conclusions

The perioperative goals and objectives for this patient were met as evidenced by the patient leaving the OR in stable condition. However, evaluation of the effects of the epidural cooling in reducing the incidence of neurological deficits were not achieved as the patient succumbed to cardiac arrest on post-op day five.

The use of the nursing care plan allowed for individualization of the care needed during the perioperative period to include this new procedure and plan for best patient outcomes and practices.

The opportunity to observe this new intervention and be part of the team that successfully managed this patient was a unique learning experience and an opportunity not to be missed. ■

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