Evaluation and Management of the Post-Surgical Patient in the PICU-An Overview

Laura Ibsen, M.D.

Why should the Pediatrician know anything about surgery and surgical patients?

There are a number of reasons for our involvement with the surgical patients. Surgical patients are excellent examples of organisms under stress, and a great deal of acute physiology can be learned by caring for them--airway and pulmonary issues, fluid/electrolyte issues, neuroendocrine response to stress, pain and sedation, etc. The patient in ICU must be cared for in a collaborative fashion with the primary surgical service. In general, pediatricians know about infants and children, and "medical" issues, and surgical attendings/residents know about "surgical/technical" issues. If a collaborative relationship is formed, the patients will receive the best of both sets of knowledge. Finally, because of the potential for miscommunication to lead to mis-understandings and problems with care, these patients present excellent opportunities to practice the art of communication and finesse.

Post-operative care must be approached in an organized, timely manner, with attention to the acute nature of the patient's changing physiology. Before the patient arrives, you should familiarize yourself with the patient's past medical/surgical history and the planned surgical procedure. If you don't know what the disease and/or the operation is--ASK or READ! There is usually information available somewhere. Only when you know what they planned to do, and what the did it on, will you be prepared to evaluate your patient when he/she arrives, and anticipate potential problems that you must watch for.

When the patient arrives--the *initial* evaluation

The patient has just undergone general anesthesia, been intubated +/- extubated, and had some fairly invasive procedure performed. Thus:
ABCs
Look at the breathing pattern
Listen to the chest--breath sounds, stridor?
Listen to the heart--gallop, murmur?
Feel the pulses--strong, weak, thready?

The Anesthetic Record--what it contains, what you need.

The anesthetic record can be viewed as the "history of present illness" for the surgical patients--it contains information related to maintaining physiologic stability during the course of the operation. You will need to learn to read it and interpret the information it contains. Each hospital's record is somewhat different, but all will contain the following information:

1. Induction of anesthesia--IV or mask, smooth or difficult?
2. Intubation--rapid sequence?, blade and tube size used, number of attempts, any notations about anatomy?
3. Maintenance of anesthesia--potent inhalational agents (halothane/isoflurane/sevoflurane), nitrous oxide, narcotics, propofol. Regional techniques--epidural, caudal, local infiltration or

Nerve block.
4. Ventilator parameters-rate, tidal volume, FiO2
5. Vital signs-BP, HR, SaO2, temp
6. Fluids--ins and outs-type or fluid, crystalloid/colloid/blood
7. Blood loss
8. Any "events" should be recorded
9. Extubation-problems, especially bronchospasm or stridor
10. ANY drugs given (including antibiotics)
11. Lines and tubes

Fluids in the Operative and Post-operative patient

Pediatrician: "Why do they always get so much fluid?"
Anesthesiologist: "Because they need it"

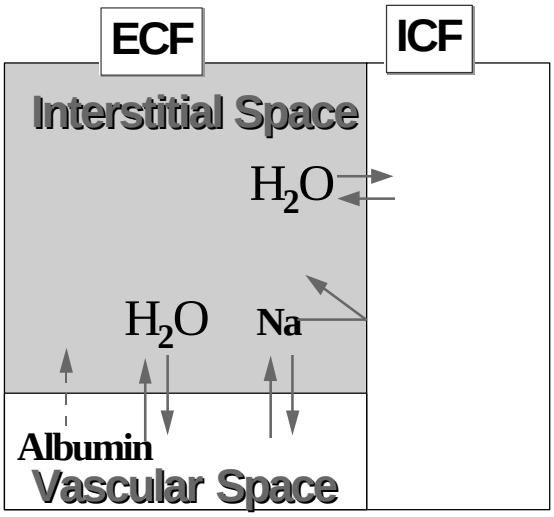
The anesthesiologist must provide maintenance (=preoperative hydration status+length of NPO+normal 4,2,1 maintenance needs) + replacement of "third space" losses (open belly, hot lights, extensive dissection of tissues) + replacement of blood loss (see later discussion). Major abdominal procedures can lead to losses of 15 cc/kg/hr in "third space" losses which must be replaced.

Effect of Anesthesia on Fluid Balance:
General anesthesia produces vasodilation and some degree of myocardial contractility (usually overcome by sympathetic drive induced by the surgical stimulus), and thus a volume bolus may be needed. Mechanical ventilation can increase evaporative loss if gases are not adequately humidified, which is often the case during long OR procedures. These factors will increase the need for volume/fluid. Other factors, including increased intrathoracic pressure brought about by mechanical ventilation, a stress response to surgical stimulus, or the prone position, may lead to increased ADH production and decreased urine output. Hence, usual fluids are isosmotic (L. or NS, with or without Dextrose), and urine output may not reflect intravascular volume status.

Assessment of Fluid Balance:
Vital signs (HR/BP) combined with a knowledge of the *amount* of anesthesia being delivered, urine output (with above caveat in mind), acid-base status, and occasional invasive monitoring (CVP, PA catheter) are used to estimate how balance the patients fluid/volume status is. As you might imagine, this can sometimes be difficult.

Types of Fluids
For resuscitation purposes (including the OR), fluids are categorized as crystalloid (salt solutions) or colloids. There is much discussion about which is better, what the cost/benefit ratio is, etc. You should at least be aware of which is which, and of the implications of choosing one over the other.

Distribution of Administered Fluids

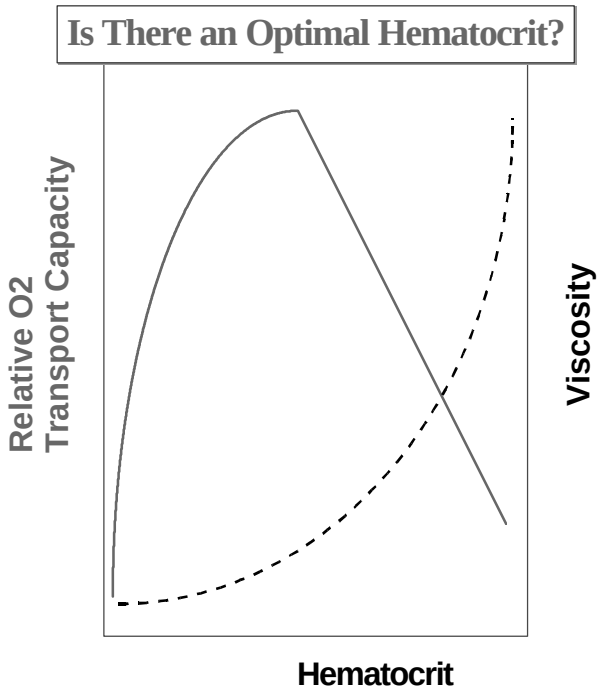


Water flows along osmotic gradient, thus water follows distribution of osmoles

Sodium will leave the vascular space and go into the interstitial space, but be excluded from the intracellular space by the Na-K exchanger. Albumin is retained more in vascular space, if the capillaries are intact. Water flows along its concentration gradient, hence, water will leave the vascular space with the sodium, and less so with albumin. Thus after about an hour for fluid shifts, 1 liter gets you about 200ccs of intravascular space if NS, about 500cc if albumin. Others:
L.--125cc
NS--180cc
5% albumin--490cc
Hetastarch--710cc
Whole blood--900cc
7.5%

<u>BLOOD loss and replacement</u>

Blood loss in the operating room is *estimated*, but this may be inaccurate, especially during long cases. One needs to consider replacing volume, cells, and coagulation factors. Coagulation factors will only become a clinically relevant issues with massive transfusion or DIC. There is controversy (in the literature and with respect to individual patients) regarding when one needs to transfuse the patient. Remember that the function of red cells is to carry hemoglobin, carried by cardiac output. O2 transport capacity will thus be a factor of Hg level and the ability of the Hg to get to cells--which will be adversely affected by hyper viscosity. Thus the "optimal" hematocrit is probably somewhere around 30-35. This does not, however address the issue of "tolerable" hematocrit--healthy patients will tolerate much lower hematocrits, and there is a risk involved in any transfusion. Hence, debate.



When to transfuse?
MABL=(EBV X (patient hct - minimum tolerated hct))/Patients pre-op hct
MABL--maximum allowable blood loss, EBV--estimated blood volume

Example--10 kg healthy child, without significant lung disease
MABL=70cc/kg x 10 kg x (42-25)/42=285cc

Thus, up to 285cc, blood loss can be replaced with crystalloid (at a ratio of 4:1), and any further blood loss should be replaced with packed cells.

Component Therapy
During a massive transfusion, coagulation factors and platelets will be reduced due to dilution, as they are not present in packed cells. What constitutes a "massive" transfusion varies, but 0.75-3.0 blood volumes is a reasonable range. If not replaced, bleeding will be greater, necessitating greater packed cell transfusion, etc. Whole blood does contain coagulation factors, but is very rarely available. One must remember, however, that those injuries which necessitate massive transfusion (IE, large blood loss with resultant acidosis and shock, severe trauma, sepsis) may also lead to DIC (disseminated intravascular coagulation), in which factors/platelets are consumed as well as diluted.

Large Volume Transfusion--other Complications
Hyperkalemia (increased K+ in supernatant of packed cells)
Hypocalcemia (citrate binding of Ca++)
Hypothermia is blood warmer inadequate or not used

Altered Oxygen-Hg dissociation curve--shift to left with most blood products (decreased 2,3 DPG), thus, Hg "holds onto" O2.

Extubation

Criteria for extubation in the operating room are the same as those elsewhere--the patient must have an adequate airway, maintain oxygenation and ventilation (adequate strength as well as lung function), and have a neurologic status able to protect the airway and maintain adequate drive. Patients can be extubated "awake" or "deep" (IE, asthmatics), but one should avoid extubation in a light plane of anesthesia, which can lead to laryngospasm.

Airway--Is there a tube leak? Is the pre-existing airway pathology that might now be worse? Did the operation affect the airway (trachea, cords, pharynx)
Breathing--Are the lungs normal or abnormal. Has there been enough fluid administered that there is concern about pulmonary edema? Did the operation involve the chest or abdomen in a way that will adversely affect the patients ability to breathe deeply?
Neuro--Has anesthesia worn off to a degree that the patient can protect his airway and have adequate drive. (Awake, following commands, spontaneous eye opening, protective airway reflexes) How much/what type of narcotic has been used? Has paralysis worn off/been reversed? (typically, paralytics will be reversed with glycopyrollate/neostigmine at the end of a case). Small/young infants are at increased risk of apnea following general anesthesia.

Any problems related to extubation should be noted on the anesthesia record, and communicated in report form the OR or PACU.

Post-Operative Issues and Problems

Respiratory

Airway--check ETT size and position if patient returns intubated (CXR).
Stridor--causes include trauma to trachea or cords, laryngeal edema, recurrent nerve damage, arytenoid dislocation. Treatment is as for viral croup--racemic epi, decadron, re-intubation if necessary.
If patient's airway is compromised due to decreased mental status, a jaw thrust and nasal airway may temporize the problem.

Pulmonary--Assess quality of breath sounds, respiratory drive. Check CXR if intubated. Generally patients will require some oxygen due to atelectasis, narcotics, and splinting.

Cardiovascular

Most pediatric patients will not have invasive monitoring in place (IE, CVP, PA line). Some will have arterial catheters. CV status must be assessed clinically, therefore, in the majority of patients. Remember that the In/Outs will not necessarily reflect the patients *intravascular* volume status (due to blood loss replacement, third space losses, evaporative losses). Of note, hypercarbia will lead to sympathetic nervous system activation, with impressive hypertension and tachycardia.

Pain

Most post-operative patients will have pain, which must be addressed in some fashion. Pain relief is best managed presumptively (IE, don't wait till the patient is in tremendous pain before treating it, and drugs must be TITRATED to effect. Modalities include narcotics (scheduled, prn, PCA), non-steroidals (ketorolac, ibuprofen), tylenol, and regional techniques (epidural, caudal catheters, nerve blocks). Titration of drugs in the infant or ventilated/sedated/paralyzed patient requires assessment of vital signs.

Common Procedures and Common Problems

Spinal Fusion--Respiratory, Pain, Fluid Balance

The post-operative course will be affected by the patient's general medical history, degree of curvature, extent of the repair, and intraoperative course (fluid balance, blood loss, narcotics given). The most dreaded complication is paralysis, and patients who are cognitively able to follow commands will be submitted to a "wake-up test" intra-operatively, before closure of the wound. Potential post op problems include respiratory depression (excess analgesia), respiratory difficulty due to splinting (inadequate analgesia), pain control (difficult), and fluid balance. Spinal fusion patients can develop SIADH with some frequency, likely due to manipulation of the spine and spinal cord. They also might not urinate due to inadequate volume restoration. Thus, if a post-op fusion does not have adequate urine output, you must decide if he is dry or developing SIADH. This can be difficult to assess on purely clinical grounds, as the overall fluid balance is always quite positive, and the HR may be high due to pain. Look at the anesthesia record for clues as to volume status (IE, is fluid replacement adequate given blood loss and duration of the case). Check a serum sodium--if high, the problem is likely inadequate volume, if low, the problem is likely SIADH. If it's still not clear, you can check a urine sodium--it should be high (>40) if the patient is volume replete (SIADH), low if volume depleted. Treat accordingly.

LeFort Osteotomy--AIRWAY, AIRWAY, AIRWAY

Various bones of the face are broken and the face re-aligned in this operation. There is typically a fair bit of blood loss and there can be significant swelling of the involved tissues. The most important things to monitor are the status of the airway and continued bleeding. If the jaws are wired shut, there should be wire-cutters at the bedside. Pain and nausea must be treated as well.

Tracheostomy--Airway, sedation, ventilation

The most critical issues for the fresh trach is not losing it. Until the tract heals, the swelling can make replacing the trach tube difficult. Hence, patients who are "wild" should be adequately sedated, especially if they were trached because they were impossible to intubate. In other situations, remember that an ETT is still an option if the tube comes out and can't be replaced (but try to avoid that situation!!!). Mechanical ventilation will depend on the underlying lung status--typically the patients return from the OR on a ventilator, and are weaned according to

their pulmonary status. There are “stay sutures” which are at the base of the incision and can be held up to help provide a “tract” should the trach tube come out.

Craniosynostosis--Blood Loss

During craniectomy for craniosynostosis one or more of the sutures of the cranium are cut. As one might expect, there is typically a large blood loss. You should be aware of whether the patient is syndromic or not (those with a “syndrome” typically have more sutures in need of repair, and might well have other problems), and the extent of the repair. Because of the large blood loss, they typically receive quite a bit of fluid intra-operatively as well as post-operatively. Monitor fluid balance, respiratory status, and blood loss (dressing).