*ENHANCED RECOVERY AFTER SURGERY (ERAS) Protocol*
*For MAJOR ABDOMINAL SURGERY*

*Colorectal, Pancreatic Surgery and Major Ventral Hernia Repairs*
*Gearhart, Duncan, Nguyen, Magnuson*

JOHNS HOPKINS MEDICINE
JOHNS HOPKINS BAYVIEW MEDICAL CENTER

Pre-operative

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| **Prep** | • Patient education in clinic<br>• Gatorade 2 hours prior to hospital arrival (except in DM Type 1, okay in DMII)<br>• Bowel prep |
| **Pre-medication**<br><br>Ordered by surgical team | • Acetaminophen 1gm PO x 1<br>• Gabapentin 300-600mg PO x 1 (300mg for age>70 or frail, do NOT give to dialysis patients)<br>• Celebrex 200 mg PO x 1 (do ***not*** give to pts with allergic-type reactions to sulfonamides)<br>• Scopolamine patch x1 (do not give to pts with narrow angle glaucoma or elderly)<br>• *Heparin SQ on chart: pre-op RN will hold if epidural placement (give 1-hr post placement in OR)* |
| **Regional Anesthesia**<br><br>Performed by APS/Regional Team | Open cases<br>• Mid to low thoracic epidural (T7-10 for colon or pancreas surgery, T10-T11 for rectal surgery, communicate with surgeon RE: incision location for large ventral hernia for optimal placement)<br>Laparoscopic cases & Ileostomy Reversals<br>➢ TAP blocks performed after induction of anesthesia<br>○ Remember to OMIT IV lidocaine with induction if TAP blocks performed<br>○ Discuss total allowable local anesthetic dose with Regional team to determine if surgeon case use additional local for port-site infiltration, encourage surgeon to infiltrate remaining local |
| **Intra –operative** | |
| **Lung-Protective Ventilation**<br><br>**Pain Control**<br><br>➢ NEW | **ALL Cases**<br><br>**6-8 ml/kg tidal volume based on predicted body weight, PEEP 2-5 cm $H_20$, 50% $FiO_2$**<br><br>**IV Magnesium** 2 g/h rate for 2-h infusion= 4 g total; start on induction, Mg has analgesic and anesthetic sparing effect; beware may augment muscle relaxant |

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| **Anesthetic & Pain Management** | ***Epidural Cases*: Duncan & Gearhart routinely for open cases, Nguyen and Magnuson upon request**<br>The goal is to maximally utilize the epidural to completely eliminate IV narcotics and minimize other anesthetic agents so patients have quicker, clearer emergence with less nausea. Please call Attending/APS to troubleshoot epidural if issues with intra-op pain control<br>• If BP tolerates, consider epidural lidocaine bolus (approx. 30-50 mg) 5-10 minutes pre-incision to achieve level if test dose is likely to have worn off (i.e., been > 1 hr or so since placement)<br>• <u>Remember heparin 5000 U SC 1 hr after epidural insertion, best to mention during timeout</u><br>• Run infusion of 0.25% bupivacaine throughout case (3-6 ml/hour epidural) as tolerated<br>• During shortage, run 0.5-1% lidocaine (3-6mls/hour) epidural as tolerated<br>• *If epidural working but need to increase spread caudad or cephalad to cover surgical stimulation, consider injecting up to 10mls sterile normal saline into epidural space to increase coverage*<br>• *Recommend using a BIS monitor and significantly <u>reducing</u> your volatile anesthetic with epidural*<br>• PACU: PACU RN will set up bupivacaine 0.0625% epidural cassette (Regional/APS team will order)<br>***TAP Block Cases:* Duncan & Gearhart routinely for lap cases, Nguyen and Magnuson upon request**<br>• Regional/APS will begin setting up for block during induction and place block after induction<br>• They will indicate how many mls of local anesthetic can still be given, encourage surgeon to use it<br>• TAP blocks provide pain control to anterior abdominal wall and will usually <u>reduce</u> the amount of opioid needed intraoperatively for minimally invasive surgeries<br>During ileostomy reversals, surgeon may briefly probe finger deep into abdominal cavity- because the TAP block only covers the abdominal wall and not deeper structures, this may cause sudden extra stimulation/pain for patient. Resist chasing this brief stimulation with narcotics or else the patient may be excessively drowsy waking up.<br>***If NO EPIDURAL OR TAP BLOCK***<br>• IV Lidocaine 1.5mg/kg bolus on induction + ~1.5 mg/kg/h infusion started as early as possible<br>• Lidocaine gtt reduces anesthetic requirement, reduce volatile anesthetic and <u>dc volatile early</u> at end of case, especially in frail/elderly (see page 4 for more info)<br>• Consider ketamine in chronic pain or open cases with no epidural (approx. 0.1-0.25 mg/kg/hour)<br>***KETOROLAC***<br>• Use judgement and communicate with surgeon, Duncan and Gearhart generally okay except:<br>• NEVER in esophagectomy or total gastrectomy (i.e., anything with esophageal anastomosis)<br>• Nguyen doesn't want and Magnuson, just ask. |
| **Fluid Management**<br><br>Clearsight Monitor to guide (excludes simple ileostomy reversals) | The goal is to give just the right amount of fluids to fill the intravascular space to optimize organ perfusion and oxygen delivery; i.e., not too little fluids which leads to hypo-perfusion and organ dysfunction and not too much to cause organ edema. **<u>ERAS does NOT mean fluid restriction</u>**.<br>1) Maintenance fluids: LR infusion 3ml/Kg/hour for open cases, 1-3ml/kg/h for lap cases<br>-Use adjusted body weight if very obese, which is approximate Ideal Body Weight + 30% http://www.manuelsweb.com/IBW.htm<br>2) Additional fluids as needed using goal-directed boluses guided by SV/SVV on Clearsight<br>–Can omit Clearsight on ileostomy takedowns, "zero-balance" fluid management okay<br>• 5% Albumin (250ml bottles) will be used for fluid boluses (get 2-3 from pharmacy for bigger cases)<br>• Record initial stroke volume (SV) (See EPIC events "ERAS" tab for easier charting) |

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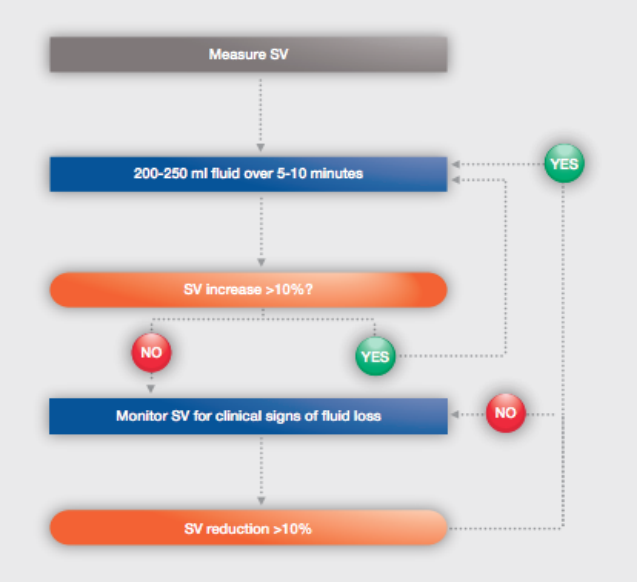
| Tech will bring device to room, please set up prior to case | • After incision (after pneumoperitoneum for laparoscopic cases) give a **150ml** Albumin 5% solution bolus rapidly (ideally give over less than 10 minutes to best appreciate hemodynamic changes)<br>○ If SV increases by >10 % the patient is **volume responsive→ finish the 250ml bottle**<br>○ If SV increases by < 10% patient is **NOT fluid responsive** and does not need further bolus at this time, clinical scenario may change later so please re-evaluate as needed<br>○ **If patient was FLUID RESPONSIVE AND THERE ARE CLINICAL SIGNS OF FLUID DEFICIT:**<br>○ Repeat additional boluses of 100-150 mls colloid until no longer responsive, **OR** no signs of fluid deficit; again only continue bolus **IF clinical indication for fluid (e.g. hypotension)**<br>○ Use up to 2-3 bottles of 5% Albumin for case, if further boluses required, subsequent boluses with LR 250 mls at a time<br>○ *This is different than before, previously, we tried to MAXIMIZE the stroke volume and reach the "peak" of the Frank-Starling curve. We are no longer necessarily achieving a "peak" value for everyone. Instead, we are trying to just OPTIMIZE the stroke volume without giving unnecessary fluids, which for some patients may be AT THE PEAK OF THE STARLING CURVE AND OTHER PATIENTS MAY NOT NEED TO BE AT THEIR PEAK.*<br>○ *In summary, we are giving fluids if they are 1) fluid responsive and 2) there is also an indication to give fluids like hypotension.*<br>○ If still hypotensive despite seeming intravascularly "full" consider phenylephrine<br>○ Use cardiac output monitor information to guide fluid management in conjunction with other clinical data (e.g., information from ABGs/labs/pleth variability) |
| **PONV Management** | [Scopolamine given in pre-op]<br>Dexamethasone 4-6 mg IV before incision (or early as possible) if no concern for blood sugar control<br>Ondansetron 4-8 mg end of case |
| |  <br>Fluid responsive +<br>Signs of hypovolemia =<br>Give fluids<br>**UK National Institute for Health Clinical Excellence (NICE Protocol)** |

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| **More information**<br>**For anyone still reading this…** | **Pain Management**<br>If the patient has had all the oral **multi-modal pre-meds** (Gabapentin, Celebrex, Tylenol), there will be a slight reduction in their intraoperative opioid requirement in laparoscopic/minimally invasive. This may be hard to appreciate intra-op, but you may find the patients take longer to wake up and are drowsier on wake up if you use the same amount of narcotics as usual.<br><br>**IV lidocaine** infusion also will reduce the MAC requirement and opioid requirement. There are fewer human studies on this but probably on the order of 10-20% reduction.<br>https://www.openanesthesia.org/mac_reduction/<br><br>Running an **epidural infusion intra-op will *significantly* reduce the MAC requirement**, which is part of the whole point of using the epidural. Epidural infusions reduce anesthetic requirement by approximately 30-50% (probably on average around 35%). Also, using the epidural to blunt the surgical stimulation maximally will decrease the inflammatory response to surgery and improve recovery. So please use your epidural maximally, place a BIS monitor if it reassures you and turn your gas way down (0.5 MAC is very reasonable). It's better to run 5-6 mls/hour with less gas than 3mls/hour with more gas. Patients will wake up much more quickly and clearly, with less lingering effects of volatile (delirium, drowsiness, nausea) and have significantly reduced surgical stress response. This is beneficial to all patients, particularly elderly patients.<br>http://anesthesiology.pubs.asahq.org/article.aspx?articleid=1944713<br><br>It's best to achieve **adequate epidural block *prior* to incision** so the patient is insensate to incision. As mentioned above, using the epidural to blunt the surgical stimulation maximally will decrease the inflammatory response to surgery. The test dose has almost certainly worn off by the time of surgical incision since it takes so long from time of placement until incision. Using **epidural lidocaine bolus (30-50mg)** or a few mls of bupivacaine 0.25% a few minutes before incision works well. Also, use 0.4mg of hydromorphone in the epidural to augment your epidural block (you will be able to use less local this way and have less blood pressure effect). You may need to support the blood pressure briefly before incision but this is better than the patient "feeling" incision. Also, you will have IV magnesium running around this time which may augment the hypotension. If you are very concerned about hypotension, you *can* start the epidural bupivicaine infusion well before incision, but this needs to be done well in advance to really be effective and probably still needs a small bolus dose in most cases. Starting a bupivacaine 0.25% infusion of 3mls/hr just before incision is usually inadequate for incision.<br><br>**Epidural coverage can be spread** caudad or cephalad using sterile saline in the epidural space. For example, you may need to spread the coverage in rectal cases when there is pelvic stimulation very low/deep for parts of the procedure. Density of an epidural block can be improved by using higher concentration of local (e.g., Lidocaine 2%, Bupivicaine 0.25%). Inadequate intra-operative analgesia should be treated with some form of epidural bolus.<br><br>As already mentioned above, during **ileostomy reversals**, the surgeon may briefly probe their finger deep into the abdominal cavity- because the TAP block only covers the abdominal wall and not deeper structures, this may cause sudden extra stimulation/pain for patient. Resist chasing this brief stimulation with narcotics or else the patient may be excessively drowsy waking up as that stimulation/pain is usually brief. |

**Fluid Management**

The goal is not too little and not too much fluids, but just the right amount. This is more and more being referred to as a "zero-balance" approach. The Clearsight is a tool to try to achieve this. It should be used in conjunction with the other standard tools we have always used, HR, BP, pleth variability and urine output (see below) while realizing the limitations of each tool and variable. When

*Urine output*

Anuria is always abnormal and should always prompt immediate intervention/work-up. However, despite traditional belief, oliguria (i.e., UOP < 0.5cc/kg/hour) has been demonstrated to be a normal "stress" response to surgery and anesthesia (via ADH release) and may even have some clinical benefit. There is data to suggest that "chasing" oliguria may be harmful when all other hemodynamic indicators suggest euvolemia. So in cases of isolated oliguria, this should NOT prompt fluid therapy so long as some urine is continuously trickling and all other hemodynamic indicators are normal. Additional fluid therapy should not be given for the sole purpose of treating oliguria. (Refer to Thiele et al. 2016 for consensus statement on fluid management). This can sometimes be an uncomfortable practice for us- I suggest following the creatinine on POD 1 for patients undergoing goal-directed fluid therapy to get feedback on your management. Also, follow up on UOP in recovery: you will often see a dramatic increase in UOP in recovery. If you are really uncertain of the volume status, particularly in long cases and/or high risk patients (e.g., kidney ds, multiple comorbidities) it can be helpful to draw a blood gas and look at lactate to get a sense of adequate perfusion.

*Devil is in the details*

The **sizing of the finger cuff** is very important to get right (use little paper measurement tool hanging on monitor). Just as an oversized/undersized BP cuff with underestimate/overestimate the BP, the same will happen to an even more exaggerated degree if the cuff is mis-sized. Try to find a finger that fits one size really well (I often move the pulse ox). If a patient is right on the border of a medium and large, I find it's more accurate to size up, but better yet, try to find a finger with a perfect fit.

*Info doesn't seem right?*

If the information from the Clearsight does not seem to agree with the rest of the clinical situation, reset and start over…check your cuff fit, check that patient info is entered correctly, re-zero, check transducer level. Start over and give another small fluid bolus (i.e. 100-200mls crystalloid) and start the process over again to see where you are if you are unsure. An extra 100-200 cc's of fluid to assess the situation isn't going to hurt patient. Get labs if there have been a lot of fluid shifts and you're not sure.

*Need to get more info?*

More advanced information like ABGs with attention to lactate and Hgb should be used when there is clinical concern and for long cases with lots of fluid shifts. In a large, open belly case going on > 4 hours, it's good to get at least one set of labs after a few hours in to see where you are and then repeat the labs if they were deranged to make sure you have fixed it appropriately. Cr will rise quickly so can be a good indicator of potential pre-renal (hypovolemic) kidney injury. Also, be careful not to use the information from the Hemocue in isolation. In a big belly case when you've given a significant amount of fluids, a "normal" or high Hgb from a Hemocue could indicate that the patient is significantly under-resuscitated and the blood is hemo-concentrated. High lactate is usually an indicator of a metabolic acidosis, which in the OR setting is often (but not always) an indicator of hypo-perfusion (i.e., anaerobic metabolism).

*SV vs SVV*

Stroke volume variation has been used frequently to assess fluid responsiveness on the Frank-Starling curve with SVV> 13% indicating fluid responsiveness BUT the downside is that SVV requires 1) controlled mechanical ventilation (with either consistent volume or consistent pressure which may not always be the case with PCV-VG mode) 2) at least 8cc/kg TV and 3) normal sinus rhythm and 4) intact chest wall. PEEP may confound SVV in hypovolemic patients, causing increased SVV but this can be overcome with volume resuscitation. SV does not have these requirements, so we use SV primarily to guide our fluid resuscitation and SVV as a secondary piece of information, realizing its limitations and requirements to interpret accurately.

*Bolus quickly…*

It's important to bolus quickly (i.e., syringe it in) if you're not sure where you in terms of fluid responsiveness. If the "bolus" trickles in or is just hung to gravity, the venous system will gradually accommodate the volume and you may not appreciate any change in SV. This is especially true if the patient is super dry and there is plenty of venous capacitance. If the patient is hypovolemic and the bolus is too slow, it may only raise the SV very briefly but not enough to sustain it so if you look at your numbers, it seems like they haven't changed and it was in fact a *falsely* "negative" fluid challenge. This has long lasting consequence the whole case because you may be using an incorrect "peak" value which was very low and subsequently running the patient dry the whole case. For example, I had one case that the patient seemed very dry by all clinical indicators but the provider said the fluid challenges were negative so she thought the patient was full. I starting rapidly syringing in my bolus and saw the SV dramatically increasing (from 50 to 90!) while I was pushing the fluids. However, very soon after I would pause- the SV would instantly drop back down to the starting point around 50. In this case, the patient was so far behind on fluids that the boluses didn't sustain the SV increase long enough for the provider to appreciate while the bolus was trickling in. As always, use the information from the Clearsight in conjunction with the rest of the clinical picture. *Don't get overly fixated on the number from the initial peak for the rest of the case. If it doesn't make sense anymore, re-evaluate, start over.*

*Insufflation & Position changes*

Insufflation and major position changes can make it very difficult to interpret the numbers, especially if you are doing a fluid challenge in the middle of insufflation or a drastic position change. For this reason, in the protocol I suggest starting your initial challenge after incision or insufflation, only to make the interpretation less confusing. That being said, if you think you will have plenty of time (>20 min or so) to do your fluid challenge and interpret it before incision/insufflation, by all means go ahead. Just realize that your numbers will change after insufflation/incision and it's probably not from any acute change in intravascular status. Once the numbers "settle out" after incision/insufflation/respositioning- you can use these "new" numbers as the baseline or trigger point for fluid bolus. If you go into steep trendelenburg or extremes of tilt, it can be very hard to interpret the numbers. Let them settle in the new position. If they don't align with the clinical picture, just treat the patient as you see fit and re-assess with the device once the patient is in a level position.

*Resources:*

Goal-Directed Fluid Therapy Training Modules: http://gdt.anesthesiology.uci.edu/training.shtml
Thiele, RH et al. 2016
American Society for Enhanced Recovery (ASER) and Perioperative Quality Initiative joint consensus statement on perioperative fluid management within an enhanced recovery pathway for colorectal surgery.