FINDING BALANCE

Intrinsic drive

Luminal Nutrients

“Circumstances”

Intravenous nutrients
OBJECTIVES

- Why focus on adding enteral nutrients?
  - Benefits the patient even before energy provision
  - Provide a mechanism for patient and family to actively participate in process of adaptation
  - Endgame in pediatrics is to convert to complete enteral nutrition

- How to introduce and escalate enteral therapy
  - Basic principles from the pediatric perspective
  - Transition from hospital to home and keep the momentum
  - Anticipate and negotiate obstacles
EFFECTS OF ENTERAL STIMULATION ON MUCOSAL INTEGRITY

• Lesson from Thiry-Vella loops

• Loops of intestine—non-connected exert positive influence on each other

http://library.med.utah.edu/WebPath/GiHTML/Gi162.html

THE INTESTINAL BARRIER

- Healthy villi and microvilli = surface area for contact with nutrients
- Healthy goblet cells = a protective mucus layer
- Biologic nutrient solutions have WBC’s, antibodies (IgA) and other substances to create an immune barrier.
- Motile intestines transport the slurry of nutrients and our microflora – stasis is the enemy 😊
OTHER CONSIDERATIONS

- Gastric benefits –
  - Maintain gastric acid barrier to limits pathogens
- Liver and pancreatic stimulation
  - supports bile flow and pancreatic enzyme elaboration
- Normal GI hormone elaboration
  Completes the neuro-enteric interactions/ Gastro-colic reflex, motility, hunger/satiety
EVEN IF ADAPTATION IS NOT A CONSIDERATION

- Examples of combining therapies to improve outcomes
  - “Balanced anesthesia” – iv drugs + inhaled agents + locally active agents (regional anesthesia)
  - Treatment of cancer – smaller doses of each drug in combination with other drugs and modalities (rad Tx, surgery) yields improved outcomes
  - Transplant Immunosuppression
SUSTAIN DATABASE

- Dramatic divergence between adult and pediatric patients in terms of use of enteral nutrition (specifically tube feedings)
- Virtually none in adults vs. 60%
- WHY?
ADULT

- Different disease spectrum –
  - Maybe not amenable to large volume enteral.
  - Focus is on sustaining rather than transitioning.
  - Volume repletion >> nutrient repletion (ORS) 15% vs 5%
- Pleasure of eating vs. tube feeding
  - but still 25% adults NPO
- Different profile of adverse consequences of isolated HPN
- Limited use of low profile devices for enteral nutrition
ENTERAL NUTRITION IN CHILDREN

- Profile of intestinal failure is different
- Many acquired disorders in preterm babies allow for ongoing longitudinal growth of the intestine in addition to the other compensatory changes that result in full adaptation.
- Even in term and older infants the potential for full adaptation is anticipated.
- Optimism reflected in recent JAMA publ from BCH

*Fallon etal, JAMA epub
### Table 3. Study End Points

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No. (%) of Patients</th>
<th>Length of Residual Small Intestine, cm</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean (SD)</td>
<td>Median (IQR) [Range]</td>
</tr>
<tr>
<td>Weaned from PN</td>
<td>40 (63)</td>
<td>54.6 (26.7)</td>
<td>55.0 (28.0, 75.0) [12.0-100.0]</td>
</tr>
<tr>
<td>PN dependent</td>
<td>11 (17)</td>
<td>27.3 (14.9)</td>
<td>26.0 (14.0, 41.0) [5.0-50.0]</td>
</tr>
<tr>
<td>Died</td>
<td>8 (13)</td>
<td>27.8 (10.0)</td>
<td>26.0 (20.5, 35.0) [14.0-45.0]</td>
</tr>
<tr>
<td>Underwent transplant</td>
<td>4 (6)</td>
<td>34.9 (25.0)</td>
<td>36.0 (13.5, 56.2) [9.0-58.4]</td>
</tr>
</tbody>
</table>
ENTERAL NUTRITION IN CHILDREN

• Management dictated by age of child
• Gastrostomy devices usually placed at time of original intervention
• We allow for sham feeds with foods that we may not otherwise subject the residual intestine to.
• Most neonates will develop oral aversion from
  • the support tubes we place.
  • the non-palatable formulas we offer.
  • absence of hunger to drive eating.
  • development of reflux esophagitis, vomiting
PEDIATRIC PRINCIPLES

• push feeds to tolerance and carefully beyond to provide impetus for adaptation.
• Provide a safe environment with adequate supervision to monitor for volume loss, electrolyte derangements and dehydration
• Tolerance defined loosely but generally stoma output should not exceed 30% of volume of enteral intake, or no > 8 stools a day.
• Examine nature of output – reducing substances
• Re-feeding into distal stoma if accessible- or connect GI tract
• Once at a point where pushing has to slow down, consider transition to home. Ideally at >30% enteral nutrient supply.
CASE EXAMPLE

- 8 day old term infant with intestinal infarct secondary to volvulus around mesenteric cyst
- Multiple laparotomies in first 5 days to salvage as much bowel = 40cm SB + entire colon. G-tube placed and primary anastomosis performed, TPN delivered via PICC line initially.
- Initial hyper-bilirubinemia resolved by 3 weeks and never recurred.
- Age 3 months ready for d/c home on TPN (broviac placed) and enteral feeds (PO/gavage daytime + continuous at night). EtoH lock, no other meds.
Readmitted once with line infection (Klebsiella, Lactobacillus) 2d after initial d/c and finally home at age 4 months without readmissions.

Very motivated, educated family – gave them parameters to achieve goals on weekly basis.

Remainder of management completely outpatient with successful weaning off TPN by about 6 months of age.

Now 18 months of age. Intermittent G-tube feeds
HOW TO MONITOR AND KEEP TRACK

• Bedside growth charts
• Track daily weight, weekly height
• Labs
• Volume of HPN – fluid & caloric delivery
• Volume of enteral intake and caloric delivery
• Proportion PN/EN.

• Shows you when you can increase the proportion of enteral delivery
• Assures that you keep cal/day normalized to weight
# HASBRO FLOW SHEET

## PEDIATRIC SURGERY GROWTH & NUTRITION FLOW SHEET

<table>
<thead>
<tr>
<th>Date</th>
<th>Weight</th>
<th>NAME:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Glucose</th>
<th>GGTP</th>
<th>AST/ALT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bb 1/D</td>
<td>Na</td>
<td>K</td>
</tr>
<tr>
<td>Cl</td>
<td>CO₂</td>
<td>BUN</td>
</tr>
<tr>
<td>Creatinine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>Magnesium</td>
<td>Phosphorus</td>
</tr>
<tr>
<td>Albumin</td>
<td>PreAlb</td>
<td>Hgb Hct</td>
</tr>
<tr>
<td>Platelet</td>
<td>Stool Heme/RS</td>
<td>TPN: Cc/h</td>
</tr>
<tr>
<td>Hours/day</td>
<td>Kcal/Kgd</td>
<td>Formula:</td>
</tr>
<tr>
<td>GT Feeds: ccm/h</td>
<td>Kcal/Kgd</td>
<td></td>
</tr>
<tr>
<td>PO Feeds: cc/Feed</td>
<td>Kcal/Kgd</td>
<td></td>
</tr>
<tr>
<td>Total: Kcal/Kgd</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Compensate for changing kcal/kg/day needs as they get older, recover from operations, etc. Total caloric intake will increase as they grow --- easy to misinterpret as going up on TPN.
WHEN YOU RUN INTO PROBLEMS

- Reflux compromising ability to increase feeds
- Excessively loose stools
- Behavioral issues
REFLUX AND EMESIS

- Causes pain
- Results in excessive use of antacid therapies
- Leads to oral aversion
- Leads to frustration with advancing feeds
- Make sure it is not behavioral only.

- Before you consider fundoplication
- Consider placement of a GJ tube – in essence a thirty-vella loop.
CASE EXAMPLE

- 12cm after midgut volvulus/gastroschisis – thought not to be candidate for full adaptation – faint hearted attempt at enteral feedings
- 14 mo Ex lap for SBO 48cm SB – Amazing! But emesis limits feeds.
- GJ placed
- Able to advance enteral - 40% caloric intake
- ? Fundoplication indicated
- Impedence study normal – focus on behavioral issues
ROLE OF GJ TUBES
REVERSE ENGINEERING OF GJ TUBES

• Three year old with limited adaptation now with
dilation of distal SB segment before colonic
anastomosis
• Wouldn’t eat because he would have “reverse
peristalsis” with large bilious emesis every am.
• Temporizing solution = GJ with G for feeding and J
for drainage ( incomplete diversion)
• Resulted in decompression of dilated segment and
return to more even dilated caliber
• Now to resume PO/ Gtube feeds without diversion
vs. reconsider for tapering/lengthening procedure.
LOOSE STOOLS

• Add fiber (i.e. green beans)
  • Improve colon health
  • Provide substrate for the microflora
• Mix complex nutrients with your basic formulas
  • Blenders are your friend
• Only when frequency >> volume – use lomotil type meds
• Be proactive with perianal care
MAINTAIN AGENDA AND MOMENTUM

• Easier said than done at home
• But, home is so much better than hospital
HOME CONSIDERATIONS

• So many pumps, IV poles, stuff for the refrigerator!
• TPN can be done overnight –
• Enteral feedings need to distribute over 24 hours – can’t “hide” them all at night
  • Urine output would be excessive overnight – lack of sleep
• How do you travel with all this equipment?
  • How do they go to school?
• How do you give them some normalcy when they are with others who are not in same situation? (siblings, friends)
WHO HELPS PAY FOR THIS?

• Pediatric patients
• SSI, Medicaid, commercial insurance and funding programs such as Katie Beckett in Rhode Island/SE Mass, WIC
• It becomes a balancing act with which one feels responsible (or doesn’t) for which component of care.
OTHER THERAPIES

- Often need to work with OT/Speech/ Early intervention (age<3yrs)
- Gaps in care when this care is not delivered as consistently on an outpatient basis as in the hospital
- Use resources in your own institution, but listen to results from parents using their own resourcefulness.
SOMETIMES THE REVERSE OCCURS

• How to introduce TPN on a patient that has successfully weaned and needs to return to some HPN
• Psychologically a difficult situation - and it now impacts an older child who may not remember the early years and resents the new tether (but the parents have not forgotten)
• This may become more of an issue as children go through growth spurts or don’t make it through a growth spur on the basis of inadequate nutrition
A TALE OF TWO BROTHERS

- Gastrochisis – prenatal midgut loss = 40 cm with no ICV (right colon)
- TPN until 18 months. Weaned after STEP procedure for bacterial overgrowth
- Did well- got rid of Gtube in another year
- Hyperphagic diet but terribly slow eater – his little brother finally surpassed him in height
- ? Candidate for growth hormone?
- Resumed TPN 3 days a week (weekend only) inserted a port instead of broviac- weaned to 2 days/week grew finally.
STRATEGY

- Allow acute phase of illness to resolve and initiate enteral feedings as soon as safe from surgical standpoint
- Develop a long range plan (determine the daily caloric intake necessary to achieve goals) and keep adjusting this for ongoing weight gain
- Determine efficiency of the intestine – what is the x factor – it will change with adaptation
- With good education and documentation this can be done on outpatient basis
LESSONS LEARNED

• Enteral feedings, even when minimal or involving only a portion of the gut, contribute to health of the patient
• This is accepted in the pediatric population because of the success with ultimate adaptation
• It is a cumbersome, resource intensive process, and must be customized to a patient’s needs and goals
• By maintaining a healthy gut, even in the absence of adaptation, we should be able to decrease the morbidity associated with HPN (sepsis and cholestasis)