Postoperative and PICU care of Children after Liver Transplantation

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St James’s Hospital
Leeds
Cadaveric split liver grafts

R lobe : L lobe split

R lobe : LLS split

Monosegment
Main objectives of PICU care

- Ventilate & Monitor
- Sedation & Analgesia
- Fluids and additives
- Antimicrobials
- Investigate: Bloods, CXR
- Prescribe immunosuppression
- Look for and treat complications
Post operative Ventilation

- As the process of transplantation develops, PICU care and post operative care become more routine.
- Median stay after first elective transplant in UK in 2003 was 2 days with 1 Day ventilation.
- In Hamburg there has been a progress reduction in post operative ventilation times from 5.2 days in 91-94 to 1.2 days in 96-98.
- However, a short period of ventilation remains normal practice: patients are transferred from theatre and placed on a PICU ventilator and sedated.
Sedation

- Limited range of drugs available
- Oral route not available/not reliable
- Propofol not licensed for use in children
  - Propofol syndrome: Arrhythmia during propofol infusion plus one or more of the following: Lipaemic serum, hepatomegally or hepatic steatosis, metabolic acidosis with or without raised lactate, or rhabdomyolysis with myoglobinuria
  - Concentration dependent increase in mortality:
    - (4% non propofol, 8% with 1% Propofol, 11% with 2%)
Sedation (2)

- Morphine 0-40 mcg/kg/hour
- Midazolam 0-6 mcg/kg/min
- Rectal chloral hydrate 25-50 mg/kg

Boluses frequently required to achieve adequate depth to tolerate tracheal tube and IPPV. Children may be subsequently difficult to wean.

Hence, in our unit, adoption of immediate extubation policy whenever possible.
Who do we immediately extubate?

- Consideration of immediate extubation at around bile duct formation
- Final decision shortly before skin closure
- Criteria:
  - warm, well perfused, cardiovascular stability, (no inotropes)
  - No bleeding, no on going need for blood products
  - Lactate falling, No acidosis
  - No specific surgical anxieties
Results

- June 2002-current
  (46 Transplants/40 patients)
  - 26/34 electives extubated (76%)
  - 4/12 urgent cases extubated (33%)
- 1 patient required reintubation after 4 hours (TRALI-extubated after 7 days)
- 2 others required a brief period of CPAP on day 3 (1 pulmonary oedema, 1 pulmonary oedema and RLL collapse)
<table>
<thead>
<tr>
<th>Elective Transplants</th>
<th>Extubated</th>
<th>Ventilated</th>
<th>Mann Whitney U test</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>26</td>
<td>8</td>
<td>0.1&gt;p&gt;0.05</td>
</tr>
<tr>
<td>Median age (range) y</td>
<td>11.8 (0.5-17.7)</td>
<td>0.8 (0.25-17.2)</td>
<td>NSD</td>
</tr>
<tr>
<td>Median weight (range) kg</td>
<td>28 (5.6-65)</td>
<td>8.1 (6.5-82)</td>
<td>NSD</td>
</tr>
<tr>
<td>No. patients &lt;10kg</td>
<td>7</td>
<td>5</td>
<td>(\chi^2) with Yates’ correction NSD</td>
</tr>
<tr>
<td>Graft Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole</td>
<td>12</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Left lateral segment</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Left lobe</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Right lobe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary indication for OLT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biliary Atresia</td>
<td>9</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Other chronic biliary disease</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Cystic Fibrosis</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Metabolic liver disease</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Hepatopulmonary syndrome</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Liver tumor</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Autoimmune liver disease</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median PELD score at listing (range)</td>
<td>3.4 (-10.3-28)</td>
<td>9.5 (-3.3-20)</td>
<td>NSD</td>
</tr>
<tr>
<td>PICU/Hospital bound</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Elective Transplants</td>
<td>21</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Median blood transfusion (range)</td>
<td>19mls/kg (0-100)</td>
<td>72mls/kg (0-112)</td>
<td>NSD</td>
</tr>
<tr>
<td>Mean intensive care stay ±SD (range) d</td>
<td>2.5±1.9d (1-10)</td>
<td>6.1±5.8d (2-20)</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>Mean peak ALT ±SD (range)</td>
<td>899±640 IU/L (81-2232)</td>
<td>1728±931 IU/L (707-3256)*</td>
<td>p&lt;0.01</td>
</tr>
<tr>
<td>Mean peak INR ±SD (range)</td>
<td>1.85±0.31 (1.5-2.5)</td>
<td>2.14±0.46 (1.6-2.7)*</td>
<td>NSD</td>
</tr>
</tbody>
</table>

* n=5 (excluding 3 primary non-functions)
### Table 2: Super-urgent transplants

<table>
<thead>
<tr>
<th></th>
<th>Extubated</th>
<th>Ventilated</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Median age (range)</td>
<td>13 y (0.7-15y)</td>
<td>10y (0.9-15y)</td>
</tr>
<tr>
<td>Median weight (range)</td>
<td>40kg (8.5-63)</td>
<td>30kg (7.8-82)</td>
</tr>
<tr>
<td>Graft Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole</td>
<td>3</td>
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<td>Left lateral segment</td>
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<td>1</td>
</tr>
<tr>
<td>Left lobe</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Primary indication for OLT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute liver failure (UNOS status 1) in all except one extubated with acute Budd-Chiari syndrome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median PELD score at listing (range)</td>
<td>28 (-4.5-33)</td>
<td>31.7 (14.6-43.2)</td>
</tr>
<tr>
<td>PICU Hospital bound</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Mean blood transfusion ±SD</td>
<td>33±25mls/kg</td>
<td>30±32mls/kg</td>
</tr>
<tr>
<td>Mean intensive care stay ±SD (range)</td>
<td>2.8±1.0d (2-4)</td>
<td>3.8±2.0d (2-8)</td>
</tr>
<tr>
<td>Mean peak ALT ±SD (range)</td>
<td>1144±428 IU/L (674-1700)</td>
<td>1044±485 IU/L (384-1545)</td>
</tr>
<tr>
<td>Mean peak INR ±SD (range)</td>
<td>2.3±0.96 (1.3-3.6)</td>
<td>1.7±0.15 (1.6-2.0)**</td>
</tr>
</tbody>
</table>

*5 with Grade 3-4 encephalopathy, 7 ventilated
** n=7 (excluding single primary non-function)
Table 3: Reasons for not immediately extubating after liver transplant

<table>
<thead>
<tr>
<th>Elective transplants (n=8)</th>
<th>Super-urgent transplants (n=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary non-function (2)</td>
<td>Preoperative ventilation (7) - grade 3-4 encephalopathy (5), cardiovascular instability (1)</td>
</tr>
<tr>
<td>Poor nutritional state with renal/respiratory failure (2)</td>
<td>Primary non-function (1)</td>
</tr>
<tr>
<td>Donor hepatic artery trauma (1)</td>
<td></td>
</tr>
<tr>
<td>Small donor hepatic artery (right lobe graft) (1)</td>
<td></td>
</tr>
<tr>
<td>Prolonged retransplant (1)</td>
<td></td>
</tr>
<tr>
<td>Reason not documented (1)</td>
<td></td>
</tr>
</tbody>
</table>
Table 4: Initial blood gases after immediate extubation

<table>
<thead>
<tr>
<th></th>
<th>Elective transplants (n=24*)</th>
<th>Super-urgent transplants (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean arterial pH ± SD (range)</td>
<td>7.41±0.05 (7.29-7.51)</td>
<td>7.46±0.07 (7.36-7.52)</td>
</tr>
<tr>
<td>Mean arterial pO₂ ± SD (range)</td>
<td>25.8±12.4 (9.4-57)</td>
<td>27.6±19.7 (10.3-56)</td>
</tr>
<tr>
<td>Mean arterial pCO₂ ± SD (range)</td>
<td>5.4±0.8 (4.4-7.1)</td>
<td>5.3±0.8 (4.6-6.1)</td>
</tr>
</tbody>
</table>

*Initial arterial blood gas data available for 24 of 26 patients (one missing data, one venous gas)
Most patients were receiving supplementary face-mask O₂
Analgesia

- Morphine as infusion, PCA or NCA
  - ½ body weight (kg) in 50 mls
  - 1ml = 10mcg/kg
  - 0-4mls/hour = 0-40 mcg/kg/hour
- PCA same formulation (over 4 years)
  - 0-2ml background
  - 1ml bolus
  - 5 min lockout (longer lock out if NCA)
Analgesia

- Some suggest reduced requirement for analgesia
- Shelly & Park looked at the disposition of morphine in two children postoperatively and observed that they both metabolised morphine normally
- Adult study has shown reduced requirement for morphine after liver transplantation compared with liver resection
- Others have shown increased metencephalin levels in liver postoperative transplant recipients compared to other controls.
- We measured morphine requirements of 19 children after OLT.
  - 9 infusion: mean dose 23.3 mcg/kg/hour (18-43)
  - 10 PCA: mean dose 35.6 mcg/kg/hour (20-58)
  - No controls but requirements are in standard range used
AMAZING
Sleeping peacefully just hours after the liver transplant that saved his life, little William stuns doctors with his recovery: PAGES 2-3
Analgesia-Regional

- Nil published except caudal case report
- 14.9 kg child caudal with 0.6mg of Duramorph
- Immediately extubated and off oxygen within 6 hours after transplant
- Required minimal pain control in first 18 hours
Co-analgesics

- Commonly prescribed to enable morphine sparing
- NSAIDs avoided in analgesic doses because of risk of gastric erosions
- Paracetamol
  20mg/kg 6 hourly orally or rectally
  Other UK centres use maximum 60 mg/kg
  Some evidence of transiently altered paracetamol metabolism until at least 10 days post-operatively.
Fluids

- Maintenance: 5% Dextrose
- Hyperglycaemia common even in infants
- Some centres fluid restrict (2/3 maintenance)
  (100% maintenance = 4mls/kg 0-10kg, 2mls/kg 10-20kg, 1ml/kg after)
- Drain losses: (1/2 replace with albumin and 5% dextrose)
- Nasogastric losses: Normal saline
- Additives: Mg2+, Ca2+, K+
- Hb 8-10g/dl, Monitor PT-avoid FFP
N Acetyl Cysteine

NAC attenuates tissue hypoxia in acute liver failure and immediately after reperfusion.

We currently leave an infusion of 100mg/kg/24 hours running until after the ALT has peaked.
Complications

- Graft dysfunction
- PNF, HAT, Venous out flow problems
- Later bile duct stenosis, leak
- Infection
- Renal
- Neurological
- Metabolic
Respiratory problems

- Pulmonary oedema
- Pleural effusion
- Pneumonia
- Diaphragmatic dysfunction
Monitoring Cardiovascular Status

Heart rate: ECG
Oxygenation: Pulse oximetry >95%
Invasive blood pressure monitoring
Systolic: 90+age X 2
Urine output : >1ml/kg
CVP: 5-10 mm Hg ventilated children
Cardiac Output monitoring
The LiDCO System™

Lithium dilution curve on LiDCOplus Screen
PulseCO Screens

Graph Screen

Trend Screen

Chart Screen
PNF

☐ Absent synthetic and metabolic function

☐ Clinically
  - On going metabolic acidosis
  - High lactate
  - Still needing inotropes
  - Oligo/Anuria
  - Coagulopathy
  - ALT high

☐ Hyperacute rejection/Preservation injury
Sepsis

- Bacterial infections most common
  - Culture all sites
    - Strep Faecalis
    - Strep viridans
    - Pseudomonas
    - Staph aureus
- Fungal infection occurs more commonly in ALF
  - Candida Albicans
  - Aspergillus
- Pneumocytis prophylaxis from day 5
- CMV mismatch gancyclovir/acyclovir from day 2
Renal Problems

- May be secondary to intra-operative insults
- May be sign of post operative dysfunction
- Early oliguria may be stress response

**Treatment options**
- Fill/maintain good filling pressures with inotropes if necessary (usually Noradrenaline)
- Frusemide
- Dopamine
- Dialysis

- Mortality higher in children who require dialysis after transplantation
Neurological Problems

- Reduced seizure threshold
- Aim
  - Stop fit-Lorazepam
  - Prevent further fits-Phenytoin
  - Treat cause
- Pyrexia, Metabolic derangements, intracranial bleeding, hypoxia, hypocalcaemia, hypomagnesaemia
If liver works well and obey some simple guidelines it’s a breeze!

If the liver does not work and things start to go wrong it’s a nightmare!
HALF MAN’S LIVER
SAVES OP TOT BEN

TRANSPLANT surgeons saved a tot’s life — by giving him HALF an adult liver.

They decided to carry out the 12-hour op after a child donor could not be found for Ben Scrimshaw.

Little Ben would have died within a year without the organ swap.

Medics at St James’s middle-aged man’s liver after he died from a brain tumour. A teenage lad got the other half.

Ben is now home in Bolton-on-Dearne, South Yorks — in time for his first birthday next week.

Mum Kerry, 31, said yesterday: “He’s just a different little boy, full of life, full of mischief.”

Ben’s liver condition had got so bad his skin turned yellow and his eyes were bright green.

The new organ will grow with him. Surgeon Mark Stringer said: “It should perform well for the rest of his life.”

By MARTYN SHARPE

Ben . . . “full of mischief”