ANAESTHESIA FOR LIVER RESECTIONS

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Consultant Anaesthetist
University Hospital of Wales
Cardiff
UK
Not an expert in liver anaesthesia

Scholar definition of an expert:
somebody who perfected and practiced that task for 4 hours every day for 10 years

Practical definition of an expert:
Somebody with slides from a different hospital
University Hospital Of Wales, Cardiff
Sighisoara
Anaesthesia for Liver Resections

• History

• Anatomy & terminology

• Main principles & technique

• Cardiff experience

• Future

Ateleanu B, Kumar N, J Rom Anest Terap Int 2011; 18: 27-33
History 1

- 1870 – liver trauma
- 1888-91: Langebuch, Tiffany, Lucke
- Keen 1899: 76 resections, 14.9% mortality
- Wendel 1911 – anatomical hemihepatectomy: 9 years survival
- Pringle 1902
- Anschutz 1903 – digital fracture
- Stancescu 1975 – 41 resections, mortality 22%, no 1 year survivors
History 2

Until 20-30 years ago formidable operation:

• Thoraco-abdominal approach

• Classic surgical instruments

• Clamping IVC

Stănescu et al, Rev Chir Oncol. 1975 Mar-Apr;24(2):105-12
Devastating complications:

- Torrential haemorrhage + exsanguination
- Hepatic venous air embolism
- Hepato-renal failure
- Biliary leakage
- Diaphragmatic injuries
- Subphrenic abscess
- Ascites

Foster et al, Arch Surg. 1991 Mar;126(3):381-7
What`s so special about the liver?
How Anesthetists see themselves:

How others see Anesthetists:
Macro-Anatomy

- 2 Lobes – 8 Segments
  1500g - 2%TBW
- Dual blood supply
- “Law of thirds”:
  - CO
  - Blood flow
  - O2

Histology

- Hepatic lobule
- Hepatocytes:
  Hypoxia (Halothane)
  Regeneration
## Terminology 1

**First-order division**

<table>
<thead>
<tr>
<th>Anatomical Term</th>
<th>Couinaud segments referred to</th>
<th>Term for surgical resection</th>
<th>Diagram (pertinent area is shaded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Hemiliver OR Right Liver</td>
<td>Sg 5-8 (+/-Sg1)</td>
<td>Right Hepatectomy OR Right Hemihepatectomy (stipulate +/-segment 1)</td>
<td>![Diagram of liver showing segments]</td>
</tr>
<tr>
<td>Left Hemiliver OR Left Liver</td>
<td>Sg 2-4 (+/-Sg1)</td>
<td>Left Hepatectomy OR Left Hemihepatectomy (stipulate +/-segment 1)</td>
<td>![Diagram of liver showing segments]</td>
</tr>
</tbody>
</table>

*Border or watershed:* The border or watershed of the first order division which separates the two hemilivers is a plane which intersects the gallbladder fossa and the fossa for the IVC and is called the midplane of the liver.
## Terminology 2

### Second-order division
(Second-order division based on bile ducts and hepatic artery)

<table>
<thead>
<tr>
<th>Anatomical Term</th>
<th>Couinaud segments referred to</th>
<th>Term for surgical resection</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Anterior Section</td>
<td>Sg 5,8</td>
<td>Add (-ectomy) to any of the anatomical terms as in Right anterior sectionectomy</td>
<td>[Diagram showing shaded areas representing sectionectomy]</td>
</tr>
<tr>
<td>Right Posterior Section</td>
<td>Sg 6,7</td>
<td>Right posterior sectionectomy</td>
<td>[Diagram showing shaded areas representing sectionectomy]</td>
</tr>
<tr>
<td>Left Medial Section</td>
<td>Sg 4</td>
<td>Left medial sectionectomy OR Resection segment 4 (also see Third order) OR Segmentectomy 4 (also see Third order)</td>
<td>[Diagram showing shaded areas representing sectionectomy]</td>
</tr>
<tr>
<td>Left Lateral Section</td>
<td>Sg 2,3</td>
<td>Left lateral sectionectomy OR Bisegmentectomy 2,3 (also see Third order)</td>
<td>[Diagram showing shaded areas representing sectionectomy]</td>
</tr>
</tbody>
</table>
### Terminology 3

<table>
<thead>
<tr>
<th>Anatomical Term</th>
<th>Couinaud segments referred to</th>
<th>Term for surgical resection</th>
<th>Diagram (pertinent area is shaded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segments 1-9</td>
<td>Any one of Sg 1 to 9</td>
<td>Segmentectomy</td>
<td><img src="image" alt="Diagram" /></td>
</tr>
<tr>
<td>2 contiguous segments</td>
<td>Any two of Sg 1 to Sg 9 in continuity</td>
<td>Bisectionectomy (e.g. bisectionectomy 5,6)</td>
<td><img src="image" alt="Diagram" /></td>
</tr>
</tbody>
</table>

For clarity Sg. 1 and 9 are not shown. It is also acceptable to refer to ANY resection by its third-order segments, eg. right hemihepatectomy can also be called resection sg 5-8.

**Border or watersheds:** The borders or watersheds of the segments are planes referred to as intersegmental planes.
Etiopathogeny

Metastases of:
- Colonic adenocarcinoma
- Renal carcinoma
- Carcinoid

Primary Hepatocarcinoma HCC
Cholangiocarcinoma
Gallbladder carcinoma

Benign pathology: biliohepatic trauma, abscess, cysts, hyperplasia
Patient selection

- Charlson index
  Charlson et al, J Chron Dis. 1987; 40:373–383

- Klabunde

- ACE-27

- Fong Clinical Risk Score:
  Liver resections (CRC metastases)
Fong Score: predicting recurrence after hepatic resection for metastatic colorectal cancer

1. Positive margin
2. Extrahepatic disease
3. Node-positive primary
4. Disease-free interval primary to metastases < 1y
5. Number of hepatic tumours
6. Largest hepatic tumour > 5cm
7. Carcioembryonic antigen > 200ng/ml

Last 5 criteria = highly predictive
No long-time survivor when score = 5
DR. BEANS JUST ALWAYS SEEMED TO KNOW THAT NEPHROLOGY WAS HIS CALLING
UHW Cardiff

**Surgical factors**
- Primary tumour diagnostic +/- resection
- Chemotherapy
- Metastases number pulmonary
- Predicted postoperative parenchyma

**Anaesthetic factors**
- Cardiopulmonary
- Tricuspid Regurgitation
- Anticoagulation
- CRF +/- dialysis
- Critical Care status
- CPEx – every patient?
- Optimisation CO monitoring LIMON
Anaesthetic Considerations

- Preoperative
- Intraoperative
- Postoperative
Preoperative 1

- Major upper abdominal surgery (+/- Mercedes incision)

- Cardiovascular reserve
  - Tricuspid regurgitation
  - Minimal preload

- Renal function
  - Prerenal failure

- Respiratory failure
  - Atelectasis
  - Diaphragm
  - Pleura
Preoperative 2

- Haematology & clotting
  - Warfarin

- Liver status
  - Cirrhosis
  - Residual parenchyma

- Repeated liver resection

- Positioning
  - Brachial plexus

- Critical Care status
Main Issues

- Low CVP
- Fluid restriction
- Potential massive haemorrhage
- Air Embolism
- CV instability
  - Arrhythmias
  - Minimal Preload
- Liver manipulation
- Renal failure

Soonawalla et al, Langenbecks Arch Surg. 2008 Mar;393(2):195-8
Other Issues

- Positioning
- Pneumothorax
- Warming
- Awareness
- Epidural
  - Patency
  - Bolus/Infusion
  - Concentration
  - Level

Soonawalla et al, Langenbecks Arch Surg. 2008 Mar;393(2):195-8
Feltracco et al, Transplant Proc. 2008 May;40(4):1165-8
Epidural Anaesthesia in Liver Surgery
Kumar N, Ateleanu B, Br J Pain 2014

- 70 consecutive patients over 2 years (2009-10)
- 91% success rate (20% failure rate in other series)
- Median stay 6 days

Suboptimal epidurals:
- Unilateral block
- Leaking
- Dislodged catheter

Complications:
- 5 chest infections
- 2 bacterial colonisations
- 4 wound infections
- 1 fatal liver failure

Higher success rate of optimal epidurals:
- less chest infections
- shorter hospital stay
Intraoperative

- **GA**

- **Thoracic Epidural**

- **Invasive monitoring+/- CO**

- **UO**

- **Repeated ABG`s**

- **Cell-saver +/- Level 1**
  Matot et al, Anesthesiology. 2002 Oct;97(4):794-800
  Gal et al, Bratisl Lek Listy. 2003;104(7-8):243-6

- **Warming**

- **BIS**

- **Intraoperative US**
Know the steps of the dance

- Mobilization
- Intraoperative ultrasound
- Cholecystectomy
- Extrahepatic inflow occlusion
- Posterior mobilization
- Extrahepatic venous outflow ligation
- Parenchymal transection
- Haemostasis and closure

Anaesthetic Room 1

- Venous access ++
- A-line+ baseline ABG on air
- Thoracic epidural T8-9
- Careful, but unspecific IV induction
- Cisatracurium
- PCV/PEEP
Anaesthetic Room 2

- Temperature probe
- Warming devices
- NGT
- BIS sensor
- Quadruple CVP (US-guided)
- Urinary catheter

My Doctor said "Only 1 glass of alcohol a day". I can live with that.
Maintenance 1

- Desflurane vs. Propofol (TCI)

- Remifentanil/Epidural infusion

- Inotropes “on dry”

- Fluid restriction
Hepatic metabolism

- Halothane = 20%
- Enflurane, Sevoflurane = 2%
- Isoflurane = 0.2%
- Desflurane = 0.02%
Maintenance 2

• Repeated doses Tranexamic Acid*

• Inotropic support*

• GTN

• Frusemide/Mannitol
  Kostopanagiotou et al, J Clin Anesth. 2006 Dec;18(8):570-4

• Reverse Trendelenburg
  Soonawalla et al, Langenbecks Arch Surg. 2008 Mar;393(2):195-8
The Forbidden Triad

- Albumin/HES
- Trasylol
- Dopamine
**Albumin**

**Against**

- **Cochrane Injuries Group**
  - **BMJ 1998; 317 : 235**
  - risk of death in albumin group higher than comparison group
  - six additional deaths for every 100 patients

**In favour**

- **Soni N.** Wonderful albumin. BMJ. 1995;310:887
- **McClelland DBL** Handbook of transfusion medicine. 2nd ed. London: HMSO; 1996
- **Allison SP, Lobo DN.** Debate: Albumin administration should not be avoided Crit Care. 2000; 4(3): 147–150
• Zarychanski et al
Association of hydroxyethyl starch administration with mortality and acute kidney injury in critically ill patients requiring volume resuscitation: a systematic review and meta-analysis
JAMA 2013 20;309(7):678-88

• Estrada et al
Hydroxyethyl starch in severe sepsis: end of starch era?
Crit Care. 2013 13;17(2):310
HES 2

• Mutter et al

Hydroxyethyl starch (HES) versus other fluid therapies: effects on kidney function

...”all HES products increase the risk of acute renal injury and renal replacement therapy in all patient populations”

...”a safe volume of any HES solution has yet to be determined”

...”in most clinical situations alternate volume replacement therapies should be used in place of HES products”

Cochrane Database Syst Rev. 2013 Jul 23;7:CD007594

• NHS should ban use of starch based intravenous fluids

BMJ 2013;346:f1323

• The European Medicines Agency’s Pharmacovigilance Risk Assessment Committee (PRAC) recommends suspending marketing authorisations for infusion solutions containing hydroxyethyl starch
Trasylol Side Effects
PATIENT WARNING!

Trasylol
Has Been Linked to Kidney Damage, Heart Attack & Stroke
Have you or a loved one been affected?

A Researcher Estimates 22,000 Lives Could Have Been Saved Had Trasylol Been Pulled Earlier

BREAKING NEWS

View Video from February, 17 2008
"60 Minutes" Feature Story

Trasylol Deaths & Injuries – Drug Side Effects and Recall

Thought to be the next billion-dollar drug for pharmaceutical giant Bayer, Trasylol was designed to control bleeding during heart surgery. As early as the 1980s, warnings from drug researchers indicated that the drug may cause deadly side effects. However, these reports did not derail Bayer’s tenacious pursuit of FDA approval and worldwide distribution of Trasylol. The negligent release of Trasylol despite health warnings has caused thousands of patients worldwide to suffer serious injury and/or death. The personal injury lawyers and wrongful death attorneys at Phillips & Associates are dedicated to helping injured victims and their families file lawsuits against Bayer in order to obtain justice and rightful financial compensation.

Free Case Evaluation
Call: 1-800-706-3000
Or Email us Below:

Fill out the form below if you or someone you love has suffered as a result of the drug Trasylol. Be as specific about your situation as possible.

Once all fields have been filled out to your satisfaction, click on the “submit” button.

You will be contacted by a qualified, experienced attorney as soon as possible.
Dopamine

Against

Debaveye et al
Is There Still a Place for Dopamine in the Modern Intensive Care Unit?

Jones et al
Renal-Dose Dopamine: From Hypothesis to Paradigm to Dogma to Myth and, Finally, Superstition?

In favour

Hong et al
A comparison of intra-operative blood loss and acid-base balance between vasopressor and inotrope strategy during living donor liver transplantation: a randomised, controlled study
Anaesthesia. 2012 Oct;67(10):1091-100

Taurà et al
The use of beta-adrenergic drugs improves hepatic oxygen metabolism in cirrhotic patients undergoing liver resection
J Hepatol. 2010 Mar;52(3):340-7

Heizmann et al
Ischemic preconditioning-induced hyperperfusion correlates with hepatoprotection after liver resection
World J Gastroenterol. 2010; 16(15): 1871-1878

Marx et al
Low-dose dopexamine in patients undergoing hemihepatectomy: an evaluation of effects on reduction of hepatic dysfunction and ischaemic liver injury
Dopamine

Pharmacological interventions for ischaemia reperfusion injury in liver resection surgery performed under vascular control
Abu-Amara M, Gurusamy KS, Glantzounis G, Fuller B, Davidson BR
Royal Free Hospital, London
...total of five randomised trials evaluating nine different pharmacological interventions (amrinone, prostaglandin E1, pentoxifylline, dopexamine, dopamine, ulinastatin, gantaile, sevoflurane, and propofol)
...no significant difference in mortality, liver failure, or perioperative morbidity
...all trials had high risk of bias
Dopamine

3 X BW in mg Dopamine
diluted in 50 ml:
1ml/h = 1mcg/kg/min
Intraoperative

- Hours for exposure/isolation main vessels
- Intraoperative US
- Pringle: HA, PV, BT
- Total vascular exclusion
- Table positioning/Liver manipulation
- CVP/PEEP
- UO/tachycardia (100/min)
- ABG`s

End of resection

• Fluids fast: Colloids ~ Crystalloids

HES ~ Gelofusine
  + Matot et al, Anesthesiology. 2002 97(4):794-800

Balanced solutions

Cell-saved blood +/- Xmatched blood; ideal Hb?

Epidural boluses
Decrease Remifentanil, Dopamine, Desflurane
ABG
Cell saved blood

• American Medical Councils 1986 – contraindicated in malignancy

• Accepted in uro- and gynae-oncology

• Liver transplant for HCC—need for LDF
• Not indicated if liver tumour is ruptured (10%)

Postoperative
HE'S PROUD OF HIS SURGERY...
How do we compare

<table>
<thead>
<tr>
<th>Study</th>
<th>Period</th>
<th>In Hospital Mortality</th>
<th>Indication for resection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poon et al. (1222 patients)</td>
<td>1989 - 1996</td>
<td>7.5%</td>
<td>Predominantly HCC</td>
</tr>
<tr>
<td></td>
<td>1996 - 2003</td>
<td>3.7%</td>
<td></td>
</tr>
<tr>
<td>Jarnagin et al. (1803 patients)</td>
<td>1991 – 1996</td>
<td>4%</td>
<td>Predominantly CRC mets</td>
</tr>
<tr>
<td></td>
<td>1999 - 2001</td>
<td>1.3%</td>
<td></td>
</tr>
<tr>
<td>Choti et al. (226 patients)</td>
<td>1984 – 1992</td>
<td>2%</td>
<td>CRC mets only</td>
</tr>
<tr>
<td></td>
<td>1993 - 1999</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Kumar N. (238 patients)</td>
<td>2003-2013</td>
<td>2.5%</td>
<td>CRC mets</td>
</tr>
<tr>
<td>Date</td>
<td>DOB</td>
<td>Procedure</td>
<td>Complications</td>
</tr>
<tr>
<td>--------</td>
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<td>---------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>16.5.5</td>
<td>24.8.57</td>
<td>left hemihepatectomy with retroperitoneal lymphadenectomy</td>
<td></td>
</tr>
<tr>
<td>20.10.05</td>
<td>29.5.70</td>
<td>right hemihepatectomy</td>
<td></td>
</tr>
<tr>
<td>22.0.05</td>
<td>22.9.33</td>
<td>right hemihepatectomy with excision of segment 4a</td>
<td></td>
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<tr>
<td>29.9.6</td>
<td>22.9.31</td>
<td>right hemihepatectomy</td>
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<tr>
<td>20.9.05</td>
<td>22.8.24</td>
<td>hiliar lymphadenectomy and right hemihepatectomy</td>
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<tr>
<td>6.7.05</td>
<td>02.0.49</td>
<td>rehemihep</td>
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<tr>
<td>13.7.05</td>
<td>5.1.71</td>
<td>rehemihep</td>
<td></td>
</tr>
<tr>
<td>19.7.05</td>
<td>15.9.36</td>
<td>rehemihep</td>
<td></td>
</tr>
<tr>
<td>20.7.05</td>
<td>4.8.24</td>
<td>rehemihep</td>
<td></td>
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<tr>
<td>.24.9.05</td>
<td>12.7.45</td>
<td>caudate lobectomy</td>
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<td>31.0.05</td>
<td>19.9.97</td>
<td>left lat sectionectomy</td>
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<td>7.9.05</td>
<td>13.9.43</td>
<td>laparotomy</td>
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<tr>
<td>22.9.95</td>
<td>21.3.60</td>
<td>biseg 5/6</td>
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<tr>
<td>5.10.05</td>
<td>21.1.3</td>
<td>Left hemihepatectomy with caudate lobectomy</td>
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<tr>
<td>19.10.05</td>
<td>27.4.37</td>
<td>bisegmentectomy 5,0</td>
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<td>20.10.05</td>
<td>17.1.50</td>
<td>left hemi with caudate resection</td>
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<tr>
<td>11.11.05</td>
<td>23.3.64</td>
<td>rehemihep</td>
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<tr>
<td>2.11.06</td>
<td>8.12.29</td>
<td>biseg0/7, wedge excision met in 3</td>
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<tr>
<td>7.12.05</td>
<td>2.9.54</td>
<td>mono seg 2</td>
<td></td>
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<tr>
<td>21.12.05</td>
<td>2.11.48</td>
<td>metas in seg 4, 5, 2, 3</td>
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<tr>
<td>28.12.05</td>
<td>25.7.08</td>
<td>cholecystectomy, cholechochscopy, hepjej</td>
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<tr>
<td>11.10.06</td>
<td>15.4.29</td>
<td>monosegmentectomy 2, 7</td>
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<tr>
<td>12.00</td>
<td>9.6.32</td>
<td>left hemi with caudate lobectomy with embloc odb exc</td>
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<td>11.02.08</td>
<td>7.3.39</td>
<td>left lateral sectionectomy and cholecystectomy</td>
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<tr>
<td>15.02.08</td>
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<td>left hemihep</td>
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<td>10.6.58</td>
<td>wedge excision lesion seg 5</td>
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<td>1.01.03</td>
<td>13.8.57</td>
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<td>segmentectomy 4, bisegmentation 6, 7</td>
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<tr>
<td>20.04.08</td>
<td>21.00.43</td>
<td>biseg 6, 7</td>
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<td>03.05.08</td>
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<td>2.2.67</td>
<td>segment 1, 6</td>
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<td>17.05.08</td>
<td>07.12.36</td>
<td>r hemi with caudate lobectomy</td>
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<td>21.6.08</td>
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<td>21.06.08</td>
<td>27.09.49</td>
<td>monoseg 6</td>
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<td>24.06.08</td>
<td>24.01.39</td>
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<td>19.07.08</td>
<td>01.04.39</td>
<td>double bypass</td>
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<td>20.09.32</td>
<td>monoseg 6, wedge seg 3</td>
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<td>01.08.08</td>
<td>22.06.55</td>
<td>right hemi hep</td>
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<td>28.09.08</td>
<td>28.03.34</td>
<td>monoseg 6, metastasectomy seg 3, 7</td>
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<td>04.10.08</td>
<td>04.11.37</td>
<td>excision of liver cyst</td>
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<td>rtp monoseg 4</td>
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<td>31.12.51</td>
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<td>13.12.08</td>
<td>22.06.35</td>
<td>segmentectomy 4, 7</td>
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<td>03.01.07</td>
<td>22.11.25</td>
<td>metastasectomy 4a, biseg 6/7</td>
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<td>12.01.07</td>
<td>09.09.26</td>
<td>wedge seg 3, monoseg 4</td>
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<td>24.01.07</td>
<td>02.11.38</td>
<td>lap, ious</td>
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<td>07.02.07</td>
<td>29.01.45</td>
<td>laparotomy, bx retropan node</td>
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<tr>
<td>24.02.07</td>
<td>10.08.35</td>
<td>monoseg 4</td>
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<tr>
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<td>24.03.36</td>
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New directions

• Enhanced Recovery/Fast Track:
  IT opioids +/- subcostal blocks

• CPEx

• Monitoring: LiDCO, CardioQ, TOE, new methods of non-invasive (CO) monitoring

• Laparoscopic resections: First laparoscopic liver resection in Wales performed successfully on 29/4/2010
Future

- Paediatrics

- Transplant

Lukanovic NP, Transplant Proc. 2008 May;40(4):1187-9
Any Questions?