Traumatic Lumbar Punctures in children and contributory factors:
A 10 year retrospective study

Dr Valentina Milosescu, Registrar Paediatrics, Queensland Childrens Hospital

Dr Vishal Kapoor FRACP, Staff Specialist, Queensland Childrens Hospital
Background

- Lumbar puncture (LP) is a procedure done to acquire cerebrospinal fluid (CSF), which is important in the diagnosis of a variety of infectious and non-infectious neurologic conditions.

- Haemorrhagic/Traumatic lumbar puncture (TLP) occurs due to puncturing venous plexus or vessels along the corda equina, causing bleeding in subarachnoid space (1).

- TLP may cause diagnostic uncertainty, unnecessary antibiotic use, prolonged hospital stay and harm to patients (2-4).
Aim

• The study reviewed the lumbar punctures performed at the QCH (formerly known as LCCH) and RCH over a ten year period.

  – Primary aim was to find the identifiable risk factors related to TLP.

  – Our secondary aim was to then possibly identify the modifiable factors contributing to TLP in order to reduce the number of TLP.
Factors associated with TLP

- Patient, physician and procedural factors have been highlighted in the literature

  - **Anaesthesia vs no anaesthesia** - Studies found decrease proportion of TLP with anaesthesia and a qualitative decreases the pain (3)

  - **Needle type (gauge and length) and technique (stylet vs no stylet)** - no significant association (4)

  - **Effect of age** – LP 3 times more likely to be successful (adequate CSF and <1000 RBC) if the infant was >12months (3)
Methods

- A retrospective study of LP’s conducted at two tertiary pediatrics centers in Brisbane., QCH (formerly known as LCCH) and RCH Brisbane.

- Data was collected from Queensland Pathology (AUSLAB)

- Study duration: 1/1/07 to 30/6/16. (10 years)

- Non-identifiable data e.g. sex, age as well as variables related to the lumbar puncture including CSF cytology, location and time of the lumbar puncture was extracted.

- Age range 0- 18 years.
Methods

Analysis

- Stata software 15.0
  - Categorical variables were described in proportions with 95% confidence intervals (CI).
  - Continuous variables were presented in means and standard deviations if normally distributed or medians with interquartile ranges if non-parametric.
Definitions used in the study

- Varying definitions of TLP in the literature ranging from >400 to >10,000 red blood cells (RBC) in the cerebrospinal fluid (CSF) (2-4).

In our study
- A TLP was defined as a LP with >400 RBC present.
- Alternative definition: of >1000 RBC and gross blood appearance was also considered.
RESULTS
Frequency of TLP

- We analysed a total of 491,771 lab records over 10 years data from RCH and QCH. There were **16,196** LPs performed during the study period.

- Table 1: Breakdown of LP types based on the definition of traumatic

<table>
<thead>
<tr>
<th></th>
<th>Freq</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grossly blood stained (GBS)</td>
<td>2219</td>
<td>13.70 (CI 13.67-14.75)</td>
</tr>
<tr>
<td>&gt;400 + GBS</td>
<td>3083</td>
<td>19.04 (CI 18.43-19.65)</td>
</tr>
<tr>
<td>&gt;1000 + GBS</td>
<td>2301</td>
<td>14.21 (CI 13.17-14.24)</td>
</tr>
</tbody>
</table>
Association of AGE with Traumatic LP’s
Age distribution: All LP’s
### Bivariate regression analysis

Association of AGE at different months with TLP (overall)

<table>
<thead>
<tr>
<th>Statistic</th>
<th>&lt;1mo</th>
<th>&lt;3mo</th>
<th>&lt;6mo</th>
<th>&lt;12mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odds ratio (95%CI)</td>
<td>5.4 (4.53-6.44)</td>
<td>4.21 (3.72-4.76)</td>
<td>3.57 (3.19-3.99)</td>
<td>3.18 (2.87-3.53)</td>
</tr>
<tr>
<td>P value</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

### Traumatic lumbar puncture (>400 RBC + GBS)- OVERALL

<table>
<thead>
<tr>
<th>Statistic</th>
<th>&lt;1mo</th>
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<th>&lt;6mo</th>
<th>&lt;12mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odds ratio (95%CI)</td>
<td>4.26 (3.58-5.06)</td>
<td>3.22 (2.86-3.63)</td>
<td>2.72 (2.45-3.03)</td>
<td>2.60 (2.36-2.86)</td>
</tr>
<tr>
<td>P value</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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</tbody>
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### Traumatic lumbar puncture (>1000 RBC + GBS)- OVERALL

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<th>&lt;12mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odds ratio (95%CI)</td>
<td>4.64 (3.89-5.54)</td>
<td>3.69 (3.25-4.17)</td>
<td>3.15 (2.82-3.53)</td>
<td>3.01 (2.72-3.33)</td>
</tr>
<tr>
<td>P value</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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</tr>
</tbody>
</table>
Bivariate regression analysis

Association of age at different months (overall) with TLP

• What was most significant in our findings was the highest OR was 5.4 in the <1m age group.

• There were still significant OR or 2.6- 3.18 for <12 m age group showing an increased association for TLP with this <12m age group.
Association of AGE with traumatic LP’s – In ED vs not in ED
Age distribution: LPs in ED
Age distribution: LPs outside ED

Age distribution: children with LP outside ED

Frequency

Age in months

All LP
Haemorrhagic LP
## Bivariate regression analysis

### Association of AGE at different months with TLP (for LPs in ED only)

<table>
<thead>
<tr>
<th>Statistic</th>
<th>&lt;1mo</th>
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<th>&lt;12mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odds ratio (95%CI)</td>
<td>2.63 (2.01-3.43)</td>
<td>2.63 (2.08-3.33)</td>
<td>2.55 (1.99-3.27)</td>
<td>2.98 (2.27-3.90)</td>
</tr>
<tr>
<td>P value</td>
<td>0.00</td>
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### Traumatic lumbar puncture (GBS) - In ED

<table>
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<th>&lt;12mo</th>
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<tr>
<td>Odds ratio (95%CI)</td>
<td>2.96 (2.27-3.85)</td>
<td>2.89 (2.28-3.65)</td>
<td>2.71 (2.12-3.47)</td>
<td>3.01 (2.31-3.92)</td>
</tr>
<tr>
<td>P value</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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### Traumatic lumbar puncture (>400 RBC + GBS)- in ED

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<th>&lt;12mo</th>
</tr>
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<tr>
<td>Odds ratio (95%CI)</td>
<td>2.87 (2.18-3.77)</td>
<td>2.97 (2.30-3.82)</td>
<td>3.12 (2.37-4.10)</td>
<td>3.74 (2.76-5.07)</td>
</tr>
<tr>
<td>P value</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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### Traumatic lumbar puncture (>1000 RBC + GBS)- in ED

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Bivariate regression analysis

Age at different months (for LPs in ED only)

- When compared to total LP’s the OR were smaller overall.
- The highest OR were in <12mo and a fairly small difference between age groups, unlike the previous graph which showed a the highest OR in the <1mo.

![Age and TLP in ED](chart.png)

- GBS
- >400 RBC+ GBS
- >1000 RBC + GBS
Bivariate regression analysis

Age at different months (for LPs in ED only VS overall)

Age and TLP in ED

Age and TLP

Age in months

Odds Ratio

<1mo <3mo <6mo <12mo

0 0.5 1 1.5 2 2.5 3 3.5 4

GBS >400 RBC +GBS >1000 RBC + GBS

Age in months

Odds Ratio

<1mo <3mo <6mo <12mo

0 1 2 3 4 5 6

GBS >400 RBC +GBS >1000 RBC + GBS
Association of Location with Traumatic LP’s
# Bivariate regression analysis

## Association of ED with TLPs

<table>
<thead>
<tr>
<th>Variables</th>
<th>Non-ED (T=14667)</th>
<th>ED (T=1529)</th>
<th>OR (ED) + 95%CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GBS</td>
<td>1821</td>
<td>398</td>
<td>2.5 (2.2-2.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&gt;400 RBC or Gbs</td>
<td>2667</td>
<td>416</td>
<td>1.7 (1.5-1.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&gt;1000 RBC or GBS</td>
<td>1961</td>
<td>340</td>
<td>1.9 (1.6-2.1)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Association of LOCATION and AGE with Traumatic LP’s
Association of LOCATION and AGE on Traumatic LP’s

- Stratified for age (age < 1 month) No effect of ED in stratified analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Non-ED (T=244)</th>
<th>ED (T=298)</th>
<th>OR (ED) + 95%CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GBS</td>
<td>111</td>
<td>127</td>
<td>0.9(0.6-1.3)</td>
<td>0.50</td>
</tr>
<tr>
<td>&gt;400 RBC or GH</td>
<td>124</td>
<td>138</td>
<td>0.8(0.6-1.2)</td>
<td>0.30</td>
</tr>
<tr>
<td>&gt;1000 RBC or GH</td>
<td>109</td>
<td>116</td>
<td>0.8(0.6-1.1)</td>
<td>0.18</td>
</tr>
</tbody>
</table>
Association of TIME OF DAY with Traumatic LP’s
Association of TIME OF DAY with Traumatic LP’s

Frequency of Traumatic LPs: spread over 24 hours
## Association with TIME OF DAY with Traumatic LP’s

Bivariate Regression analysis of association of TIME OF DAY with Traumatic LP’s

<table>
<thead>
<tr>
<th>Variables</th>
<th>In hours (T=12599)</th>
<th>After hours (T=3597)</th>
<th>OR (Afterhours) + 95%CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GBS</td>
<td>1188</td>
<td>1031</td>
<td>3.9(3.5-4.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&gt;400 RBC or GH</td>
<td>1755</td>
<td>1328</td>
<td>3.6(3.3-3.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&gt;1000 RBC or GH</td>
<td>1221</td>
<td>1080</td>
<td>4.0(3.6-4.4)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Multi variate analysis

Traumatic LPs: spread over 24 hours Emergency vs Outside Emergency

• In order to see if there were any confounders, we looked at 2 variables together timing of LP and the location to see again if ED vs non ED had an effect.
# Multi variate analysis –

**Traumatic LPs spread over 24 hours: Summary of affect of all variables- <1 mo**

<table>
<thead>
<tr>
<th>GBS</th>
<th>OR (CI 95%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>3.7 (3.07-4.55)</td>
<td>0.000</td>
</tr>
<tr>
<td>ED</td>
<td>1.12 (0.98-1.32)</td>
<td>0.069</td>
</tr>
<tr>
<td>Afterhours</td>
<td>3.47 (3.15-3.84)</td>
<td>0.000</td>
</tr>
</tbody>
</table>
Strength and Limitations

• **Strengths**
  - Large study
  - Small Confidence intervals and significant OR
  - Significant impact of afterhours, age and location of ED in children over 1 month – aspects we would like to target as possible areas of change to minimize the number of traumatic lumbar punctures.

• **Limitations**
  - Retrospective audit.
  - Limited information on clinical factors which may have an impact on the outcome.
  - Multivariate analysis – find some specific confounders which we would like to explore further.
What is to come

• To analyse per service area and especially in specialist areas of the hospital i.e. oncology unit
• To analyse for temporal trends over the last 10 years.
• To analyse for the seasonal trends (with increased acuity and demand in the winter months; and change of the registrar changeover times, as the guidelines for management of sepsis have changed)
• To evaluate the WBC: RBC ratios and compare them to the WBC:RBC ratios in the CSF fluid of the TLPs
Conclusion

- TLP’s proportion changes with the age, with younger than 1 year old children at higher risk and the proportion of TLPs increase afterhours with peak after 8pm.

- Age <12mo, location (for >1mo) and timing of the LP (if outside of ED) are all associated with Traumatic LP

- Contributory factors need to be explored further however these will likely strengthen our preliminary findings.

- TLPs are also likely to be different in proportion in different service areas of the hospital due to multi-factorial reasons which need to be explored further.
Thank you

• Acknowledgement: Thanks to Dr Vishal Kapoor and his contribution to the research process, statistical analysis and presentation.
References


