Understanding the contribution of intervention components: A network meta-analysis approach to psychological preparation for surgery

Rachael Powell¹, Suzanne Freeman², Neil W Scott³, Alex Sutton², Nicola Cooper², Anne Manyande⁴, Claus Vögele⁵, Julie Bruce⁶, Lucie Byrne-Davis¹, Marie Johnston³

¹ University of Manchester, UK; ² NIHR Complex Reviews Support Unit, University of Leicester, UK; ³ University of Aberdeen, UK; ⁴ University of West London, UK; ⁵ University of Luxembourg, Luxembourg; ⁶ University of Warwick, UK.
Systematic review & meta-analysis

• Is there evidence for beneficial (or harmful) effects of psychological preparation for surgery?
• Which outcomes (pain, behavioural recovery, length of stay, negative affect) are improved (or worsened) following preparation?

Methods: inclusion criteria

• Published and unpublished RCTs (NOT quasi-randomised); any language.
• Adults, elective surgery under general anaesthetic.

Intervention: pre-operative
• Procedural information
• Sensory information
• Behavioural instruction
• Cognitive intervention
• Relaxation
• Hypnosis
• Emotion-focused intervention

Outcomes: post-operative
• Pain
• Negative affect
• Length of stay
• Behavioural recovery
6781 (databases)

151 (other sources)

5116 screened (duplicates removed)

4289 excluded

712 excluded

827 full-text assessed

115 papers, 105 studies
Pain: 61
Behavioural recovery: 14
**Length of stay: 58**
Negative affect: 50

10,302 participants randomised

**Meta-analysis:**
Pain: 38
Behavioural recovery: 0
**Length of stay: 36**
Negative affect: 31
Cochrane Review Meta-analysis Results

• Post-surgery, compared with controls, patients receiving interventions experienced:
  – Lower pain (Hedges’ g = -0.20, 95%CI: -0.35 to -0.06)
  – Lower negative emotion (Hedges’ g = -0.35, 95%CI: -0.54 to -0.16)
  – Shorter length of stay (mean difference = -0.52 days, 95% CI -0.82 to -0.22).

• High heterogeneity – studies not very similar (different interventions, surgical populations).
### 2.2.1 Procedural information only

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Psychological preparation Mean</th>
<th>SD</th>
<th>Total</th>
<th>Control Mean</th>
<th>SD</th>
<th>Total</th>
<th>Weight</th>
<th>Mean Difference IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cuñado Barrio 1999</td>
<td>12</td>
<td>7</td>
<td>41</td>
<td>18</td>
<td>10</td>
<td>35</td>
<td>1.2%</td>
<td>-6.00 [-9.95, -2.05]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>41</strong></td>
<td><strong>7</strong></td>
<td><strong>41</strong></td>
<td><strong>18</strong></td>
<td><strong>10</strong></td>
<td><strong>35</strong></td>
<td><strong>1.2%</strong></td>
<td><strong>-6.00 [-9.95, -2.05]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: Not applicable
Test for overall effect: Z = 2.98 (P = 0.003)

### 2.2.2 Procedural information plus other intervention(s)

- Crowe 2003: 6.55, 4.2, 68, 10.5, 14.2, 64, 1.3%, -3.95 [-7.57, -0.33]
- Daltroy 1998: 12.5, 2.97, 58, 12.5, 2.97, 54, 5.9%, -0.07 [-1.18, 1.03]
- Doering 2000: 11.5, 2.97, 46, 11.2, 2.97, 54, 5.6%, 0.30 [0.87, 1.47]
- Felton 1976: 11, 2.97, 25, 14, 2.97, 25, 4.1%, -3.00 [-4.65, -1.35]
- Fortin 1976: 6.35, 2.31, 37, 6.44, 1.61, 32, 6.5%, 0.30 [-1.02, 0.84]
- Furze 2009: 7.61, 2.69, 100, 8.28, 4.96, 104, 5.9%, -0.67 [-1.76, 0.42]
- Giraudet 2003: 8.1, 2.5, 48, 7.9, 2.4, 52, 6.4%, 0.20 [-0.76, 1.16]
- Langer 1975: 6.7, 2.97, 30, 7.6, 2.97, 15, 3.6%, -0.90 [-2.74, 0.94]
- Lindeman 1973: 6.7, 2.97, 90, 6.65, 2.97, 86, 6.7%, 0.05 [-0.83, 0.93]
- Mahler 1995: 5.035, 1.048, 19, 6.04, 1.7, 10, 5.7%, -1.00 [-2.16, 0.15]
- Mahler 1998: 6.183, 0.41, 190, 7.14, 0.6, 67, 8.9%, -0.96 [-1.11, -0.80]
- McGregor 2004: 15, 2.97, 15, 18, 2.97, 20, 3.3%, -3.00 [-4.99, -1.01]
- Ridgeway 1982: 10.7, 2.97, 20, 8.82, 2.97, 20, 3.6%, 1.88 [0.04, 3.72]
- Schmitt 1973: 11.8, 2.97, 25, 11.8, 2.97, 25, 4.1%, 0.00 [-1.65, 1.65]
- Shuldham 2002: 10.07, 5.04, 162, 9.15, 4.38, 152, 6.1%, 0.92 [-0.12, 1.96]
- Wilson 1981: 6.887, 1.352, 36, 7.947, 1.434, 18, 7.0%, -1.06 [-1.86, -0.26]
- Zhang 2012: 7.5, 0.8, 20, 9.6, 1.7, 20, 6.9%, -2.10 [-2.92, -1.28]
- Zieren 2007: 3, 2, 50, 3, 2, 50, 7.1%, 0.00 [-0.78, 0.78]

**Subtotal (95% CI)** 1039 868 98.8% -0.57 [-1.01, -0.13]

Heterogeneity: Tau² = 0.54; Chi² = 66.83, df = 17 (P < 0.000001); I² = 75%
Test for overall effect: Z = 2.52 (P = 0.01)

**Total (95% CI)** 1080 903 100.0% -0.63 [-1.08, -0.18]

Heterogeneity: Tau² = 0.60; Chi² = 73.39, df = 18 (P < 0.000001); I² = 75%
Test for overall effect: Z = 2.73 (P = 0.006)
Test for subgroup differences: Chi² = 7.20, df = 1 (P = 0.007), I² = 86.1%
Limitations of analysis

• Could not effectively unpick impact of individual intervention components.
  – Interventions comprised 1 to 4 components.
• Need to explore causes of heterogeneity.
Secondary analysis: Network meta-analysis

- Statistical model using direct evidence (where two components are directly compared) and indirect evidence (where two components are each compared with a third treatment).
- Outcome: estimate effects for each comparison, whether or not the treatments have been directly compared.
- Can examine potential causes of heterogeneity (e.g. control group mean, type of surgery).
- Bayesian framework in WinBUGS v1.4.3.

Length of stay network diagram

P = procedural information; S = sensory information; B = behavioural instruction; C = cognitive intervention; R = relaxation; E = emotion-focussed
• **Model 1**: as for Cochrane review – compares all interventions with control.

• **Model 2**: each component has separate effect; total effect of an intervention = sum of component effects (e.g. $P+S$).

• **Model 3**: model 2 plus combinations of components (pairs of components when combined may have larger/smaller effect than if effects summed)(e.g. $P+S+PS$).

• **Model 4**: each possible combination treated as a separate intervention.
Model 2: role of components

- **Procedural info, Sensory info, Behavioural instruction, Cognitive intervention & Relaxation** each reduced length of stay; greatest effects:
  - **Relaxation** (MD -0.48, CrI: -1.35, 0.36) and
  - **Behavioural instruction** (MD -0.42, 95%CrI: -0.97, 0.06).

- In linear combination, reduction of approximately 1 day for
  - **P+S+B** (MD -0.96, 95% CrI: -1.62, -0.35) and
  - **P+S+R** (MD -1.02, 95%CrI: -2.00, -0.05).

- Evidence of heterogeneity (τ=0.81).
Causes of heterogeneity 1

- Control group mean length of stay included as continuous covariate
  - Control for typical length of stay for that operation, at that time, in that context.
  - For every 1 day increase control LoS, mean reduction of 0.10 days in intervention group LoS (95%CrI -0.16, -0.04)
  - As control LoS increases, benefit of intervention on LoS increases.
  - Slightly reduced heterogeneity (τ =0.76).
Causes of heterogeneity 2

- **Type of surgery**: cardiovascular / orthopaedic / ‘other’
  - Reduced heterogeneity ($\tau=0.68$)
  - **Procedural info** = most effective intervention for orthopaedic surgery (MD $-3.63$ 95%CrI $-5.87$, $-1.34$);
  - **Sensory info** for cardiovascular surgery (MD $-1.50$, 95%CrI $-3.12$, $0.13$)
  - **Behavioural instruction** for ‘other’ surgery (MD $-1.06$, 95% CrI $-1.93$, $-0.30$)

- Including **type of surgery AND control group mean** reduced heterogeneity further ($\tau=0.54$).
Conclusions

• Component network meta-analysis → quantify effects for individual intervention components (not possible with standard Cochrane analysis).

• Possible to control for other covariates to further understand heterogeneity.

• Can model how effects of intervention components vary with covariates.