Specific Care Question
Does decreased Operating Room (OR) traffic versus status quo result in lower surgical-site infections (SSIs) in pediatric patients?

Question Originator
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Clinical Bottom Line
A direct correlation cannot be made between operating room traffic and SSIs. However there is indirect evidence, that processes to reduce OR traffic should be in place to manage health-care associated infections.

Plain Language Summary from The Office of Evidence Based Practice
Based on very low quality evidence, it is recommended that operating room traffic be reduced to decrease the risk for SSIs. SSIs account for 17% of all healthcare-associated infection and affect 2-5% of patients undergoing inpatient surgery (Center for Disease Control and Prevention, 2009). Risk factors for SSIs fall into three main categories: patient related characteristics, surgical procedure, and surgical environment (Birgand, Saliou, & Lucet, 2015). Foot traffic in and out of the OR can lead to airflow disruption and may increase risk of SSIs (Jacob, Kasali, Steinberg, Zimring, & Denham, 2013). Disrupted air quality has been associated with SSIs (Lidwell et al., 1983) and enhancing air quality has been advocated as a means of decreasing air contamination and wound colonization (Mangram, Horan, Pearson, Silver, & Jarvis, 1999, National Institute for Health and Clinical Excellence, 2008). Door movement has been correlated directly with an elevated level of airborne bacteria-caring particles in the OR (Andersson, Bergh, Karlsson, Eriksson, & Nilsson, 2012). However, no randomized control trials have reported a direct causation between operating room traffic and SSIs.

Birgand et al. (2015) conducted a systematic review to assess impact of surgical-staff behaviors on the risk of SSI. Twenty seven studies were identified. The outcomes fell into five categories of which two were relevant to the topic of OR traffic: (a) door opening (n=11 studies) and (b) compliance with traffic measures (n=6 studies) (Table 1). There was a large variation in reported number of door openings per procedure and door openings per hour. Panahi, Stroh, Casper, Parvizi, and Austin (2012) reported the main reason for door opening in orthopedic surgery was the need for supplies (23.3%), information (11.5%), and scrubbing (7.3%); the reason was unknown for 47.3% of the door openings. The largest contributors to door openings were the circulating nurses (26%). Andersson et al. (2012) reported that out of 529 door openings, 169 (32%) were deemed unnecessary. Anderson et al. (2012) reported that 52 of the 91 (57%) air samples collected, the Colony-forming unit/m3 (CFU) values exceeded the recommended level of <10 CFU/m3. In addition, they showed a strong positive correlation (r=0.74; p=0.001; n=24) between the total CFU/m3 per operation and total traffic flow per operation.

Review by Outcome
Surgical Site Infection
Two guidelines on surgical site infections (he Center for Disease Control and Prevention, 2009; National Institute for Health and Care Excellence [NICE], 2008) identified excessive OR traffic as a modifiable risk factor for surgical-site infections. While no direct evidence was given, both guidelines recommended reducing surgical traffic as an important step to prevent surgical site infections. The AGREE II instrument (Brouwers et al., 2010) was used to grade and evaluate the guidelines. The guidelines was recommended for use by the authors of this synthesis based on the overall high quality of the guideline.
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Birgand et al. (2015) conducted a systematic review to assess impact of surgical-staff behaviors on the risk of SSI. Four of the included studies look at door opening alone or in combination with a bundle on its impact on SSI (table 2).

Young et al. (2010) reported the mean door opening of 92.9 (range, 45–205)/ case. This is equivalent to openings of 19.2 (6.4–38.2)/h, 31 min per case, and 10.7% every hour. Complex procedures were associated with higher door openings. There was a trend toward increased SSIs with increased level of door opening during surgery but it was not statistically significant (data nor p-values were reported).

Babkin et al. (2007) performed a retrospective chart review of 180 total knee replacement surgeries to identify the number of SSIs. Investigation of the problem showed three problems, one included significant traffic through the OR doors. The changes made included a horizontal air conditioner was disconnected and the OR door was locked during surgery. One and a half years after the improvements were made, a small prospective survey of 45 consecutive patients demonstrated only one SSI (2.2%) (p=0.5).

Two studies assessed the impact of a bundle, related to preventive measures that included restricted door openings, on the SSI rate (Crolla et al., 2012; van der Slegt et al., 2013). The Crolla et al. (2012) study of vascular surgery compliance with door-opening guidelines improved from 10% to 80% (p<0.001) and the SSI rate decreased concurrently by 36% (not significant). The van der Slegt et al. (2013) study evaluated gastric surgical procedures which yielded similar results with a 51% (p<0.05) decrease in SSI rates over a three years period after implementing OR bundles which included restricted door openings.

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Search Strategy and Results:
"traffic" AND (MH "Operating Rooms"), foot traffic" AND (MH "Operating Rooms"); (“operating rooms”[MeSH Terms] OR ("operating"[All Fields] AND "rooms"[All Fields]) OR "operating rooms"[All Fields] OR ("operating"[All Fields] AND "room"[All Fields]) OR ("operating room"[All Fields]) AND ("foot"[MeSH Terms] OR "foot"[All Fields]) AND (“Traffic”[Journal] OR "traffic"[All Fields])) OR ("Traffic”[Journal] OR "traffic"[All Fields]) OR (“surgical wound infection”[MeSH Terms] OR ("surgical"[All Fields] AND "wound"[All Fields] AND "infection"[All Fields]) OR ("surgical wound infection"[All Fields] OR ("surgical"[All Fields] AND "site"[All Fields] AND "infection"[All Fields]) OR "surgical site infection"[All Fields]))

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Studies included in this review:


Method Used for Appraisal and Synthesis:
The Cochrane Collaborative computer program, Review Manager (RevMan 5.1.7) (Higgins & Green, 2011) was used to synthesize the included studies. AGREE II (Brouwers et al., 2010) was used to assess the guidelines. GRADEpro GDT (Guideline Development Tool) (Schunemann, 2002) is the tool used to create Summary of Findings Tables for this analysis.
### Table 1
**Grade Summary**
**Question:** Does decreased OR traffic versus status quo result in lower SSIs in pediatric patients?

<table>
<thead>
<tr>
<th>Quality assessment</th>
<th>Impact</th>
<th>Quality</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surgical Site Infection</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 observational studies</td>
<td>very serious 1,2,3</td>
<td>serious 4</td>
<td>not serious</td>
</tr>
</tbody>
</table>

**CI:** Confidence interval
1. Unclear primary outcome measure
2. Incomplete outcome data
3. Selective outcome reporting
4. Large amount of heterogeneity between the studies
5. Patient population differ from those of interest.
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### Table 2.
Birgand 2015

<table>
<thead>
<tr>
<th>Reference</th>
<th>Design</th>
<th>Observation</th>
<th>End Point</th>
<th>Number of OR/procedures</th>
<th>Type of Surgery</th>
<th>Number/Type of Hospital</th>
<th>Results</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parikh et al. 2010</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>None</td>
<td>3/26</td>
<td>Orthopedic</td>
<td>1/University</td>
<td>2 phases: 83 and 102 DO/h; NoP, 11 (range, 7–15) and 11 (8–20)</td>
<td>All traffic should be considered essential</td>
</tr>
<tr>
<td>Andersson et al. 2012</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>Air bacterial count</td>
<td>3/30</td>
<td>Orthopedic</td>
<td>1/University</td>
<td>Median: 5 (range, 3–10) people. Correlation CFU/m³ - traffic flow (r =0.74), CFU/m³ - NoP (r =0.22); 32% unnecessary DO</td>
<td>Correlation air bacterial count and door openings</td>
</tr>
<tr>
<td>Panahi et al. 2012</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>Unknown/116</td>
<td>Orthopedic</td>
<td>1/University</td>
<td>DO, 83.2; 41/h; 39/h. vs 50/h. for revisions (P&lt;0.01); 63.1% after skin incision; 47.3% with no reason.</td>
<td>Measures to reduce OR traffic may decrease 1 etiology of SSI</td>
<td></td>
</tr>
<tr>
<td>Rackham et al. 2010</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>None</td>
<td>3/7</td>
<td>Orthopedic</td>
<td>3/Private and Public</td>
<td>DO, 27 to 169 and 68 to 169 entries/exits per operation; 26 to 60/h (pediatric)</td>
<td>Theater traffic can be substantial and need staff education</td>
</tr>
<tr>
<td>Accadbled et al. 2011</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>Unknown</td>
<td>Orthopedic</td>
<td>3/Private and Public</td>
<td>Mean DO, 25.2/h in PrH to 60/h in pediatrics; Higher in adults</td>
<td>Difference public/private; - 13.5%; − 30% if signalization</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.

A systematic review was performed to assess the impact of surgical-staff behaviors on the risk of surgical site infections.

Twenty seven articles reported data on number of people in the operating room (n=14 studies), door opening number (n=6 studies), door opening frequency (n=7 studies), door opening reasons (n=4 studies), surgical team discipline (n=4 studies), compliance with traffic measures (n=6 studies).
<table>
<thead>
<tr>
<th>Study</th>
<th>Study Design</th>
<th>Data Source</th>
<th>Event</th>
<th>Site</th>
<th>NoP and Surgeon Position</th>
<th>Impact on NoP</th>
<th>NoP and Air Microbial Contamination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Babkin et al. 2007</td>
<td>Retrospective cohort</td>
<td>OR charts</td>
<td>SSI</td>
<td>Orthopedic</td>
<td>1/181</td>
<td>NoP and surgeon position increased SSI rate</td>
<td>Impact of the NoP on the air microbial contamination</td>
</tr>
<tr>
<td>Tjade et al. 1980</td>
<td>Cross-sectional</td>
<td>Unknown</td>
<td>Air bacterial count</td>
<td>Orthopedic</td>
<td>1/Public</td>
<td>Mean Do higher before incision, 26.2/h vs. 15.4/h after; Correlation Do – air bacteria count (r = 0.55)</td>
<td>Close relationship between air bacterial count and Do</td>
</tr>
<tr>
<td>Young et al. 2010</td>
<td>Prospective cohort</td>
<td>Automatic</td>
<td>SSI</td>
<td>Cardiac</td>
<td>1/Public</td>
<td>Mean Do: 92.9 (range, 45–205), 19.2 (6.4–38.2)/h, 31 min per case, and 10.7% of every hour. Complex procedures associated with higher Do</td>
<td>Trend toward increased SSI with increased level of Do</td>
</tr>
<tr>
<td>Castella et al. 2006</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>None</td>
<td>General</td>
<td>49/All types</td>
<td>Mean NoP, 6; Do, 12 (percentile 75 = 15); &gt; 50 Do in 3% of operations; NoP higher in teaching hospitals (P = 0.001)</td>
<td>Feedback with healthcare worker was an effective instrument to audit infection control practices</td>
</tr>
<tr>
<td>Durando et al. 2012</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>None</td>
<td>General</td>
<td>1/University</td>
<td>Mean NoP, 6.6 healthcare workers and 3.1 for “clean” team; &gt; 90% of interventions with &lt; 10 HCW; Doors remained opened &gt; 50% of operative time in 36.3%</td>
<td>The number of surgical personnel present in the OR was that expected for a typical operation in a teaching hospital</td>
</tr>
<tr>
<td>Scaltriti</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>Air bacterial count/air particle count</td>
<td>Clean/contaminated</td>
<td>1/University</td>
<td>NoP at surgical cut, 7 (range, 5–8); Do, 56 (range, 22–97); No correlation; Positive correlation surgical technique/air particle count &gt; 5 μm but not between NoP/dust level or Do/dust level</td>
<td>DO representing staff movement predicted a decrease air particle count and a raise of air bacterial count</td>
</tr>
<tr>
<td>Lynch et al. 2009</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>None</td>
<td>Clean/contaminated</td>
<td>1/University</td>
<td>Do, 13 to 316, 5 to 87/h; 30% to 50% during pre-incision period; 17% of the operative time; 27%–54%</td>
<td>The rate of traffic was remarkably high supporting the need for</td>
</tr>
</tbody>
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<tr>
<td>Tartari et al. 2011</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>None</td>
<td>1/30</td>
<td>Cardiac</td>
<td>1/University</td>
<td>Compliance, 29%</td>
<td>Poor compliance with room traffic practices</td>
</tr>
<tr>
<td>Borer et al. 2001</td>
<td>Cross-sectional</td>
<td>Unknown</td>
<td>SSI</td>
<td>2/118</td>
<td>Cardiac</td>
<td>1/University</td>
<td>Compliance period 1 and 2, 62.5% and 71%, P=0.09</td>
<td>Active monitoring practices resulted in decreased SSI rate</td>
</tr>
<tr>
<td>Yinnon et al. 2012</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>Bacteriology cultures</td>
<td>70/ unknown</td>
<td>General</td>
<td>3/Public</td>
<td>SSI rate decreased in the checklist group (4% to 3%, P&lt;0.05); no decrease in the control group; Traffic rules poorly followed (25%) especially for anesthetists</td>
<td>The use of detailed checklists and monthly reports was effective in reducing SSI rates</td>
</tr>
<tr>
<td>Van der Slegt et al. 2013</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>SSI</td>
<td>Unknown/100</td>
<td>Vascular</td>
<td>1/University</td>
<td>Bundle compliance improved from 10% in 2009 to 60% in 2011; DO had</td>
<td>Bundle improved compliance with</td>
</tr>
</tbody>
</table>

**Note:** ABC, air bacterial count; APC, air particle count; CFU, colony-forming unit; CS, cross-sectional; DO, door openings; DO/h, door openings per hour; HCW, healthcare worker; NoP, no. of persons; OR, operating room; PC, prospective cohort; PM10, particulate matter 10 μm; PrH, private hospital; PuH, public hospital; RC, retrospective cohort; SSI, surgical-site infection; UH, university hospital

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### Checklist, bundles, and compliance with control measures

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<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>DO</th>
<th>SSI</th>
<th>OC</th>
<th>OR</th>
<th>Compliance/Infection Rate</th>
<th>Change in Compliance Rate</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crolla et al. 2012</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>SSI</td>
<td>Unknown/100</td>
<td>Digestive</td>
<td>1/University</td>
<td>Door movements had the lowest compliance: increase from 30% to 80%</td>
<td>Bundle improved compliance with 36% reduction of SSI rate</td>
</tr>
<tr>
<td>Moro 2006</td>
<td>Cross-sectional</td>
<td>Direct</td>
<td>None</td>
<td>92/Unknown</td>
<td>All types</td>
<td>Unknown</td>
<td>38% surgeons, 40% nurses claimed paid little attention to DO and NoP; 62% surgeons, 64% nurses had good practices</td>
<td>Surgeons and nurses paid little attention to intraoperative behaviors</td>
</tr>
</tbody>
</table>

*Note: ABC, air bacterial count; APC, air particle count; CFU, colony-forming unit; CS, cross-sectional; DO, door openings; DO/h, door openings per hour; HCW, healthcare worker; NoP, no. of persons; OR, operating room; PC, prospective cohort; PM10, particulate matter 10 μm; PrH, private hospital; PuH, public hospital; RC, retrospective cohort; SSI, surgical-site infection; UH, university hospital*
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References


Young, R. S., & O'Regan, D. J. (2010). Cardiac surgical theatre traffic: time for traffic calming measures? Interactive cardiovascular and thoracic surgery, 10(4), 526-529.