Appendix 1. Supplemental material

Search strategy

**EMBASE**

1. exp emergency health service/
2. (trauma adj (system* or care or network* or health care or model* or center* or centre* or service*)).tw,kf
3. (injury adj (system* or care or network* or health care or model* or center* or centre* or service*)).tw,kf.
4. 1 or 2 or 3
5. quality assuran*/ or quality improv*/ or benchmark*/ or clinical audit*.tw,kf. or medical audit*.tw,kf.
6. licensing/ or professional standard/ or certification/ or recertification/
7. "american college of surgeon*".tw,kf.
8. "trauma association of canada".tw,kf.
9. accreditation canada.tw,kf.
10. INESSS.tw,kf.
11. "Institut national d'excellence en santé et en services sociaux".tw,kf.
12. (designated or designation or designate).tw,kf.
13. (accredited or accreditation).tw,kf.
14. (verified or verification or reverification).tw,kf.
15. 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14
16. 4 and 15
17. remove duplicates from 16

**MEDLINE**

1. exp Trauma Centers/
2. (trauma adj (system* or network* or care or health care or model* or center* or centre* or service*)).tw,kf.
3. (injury adj (system* or care or network* or health care or model* or center* or centre* or service*)).tw,kf.
4. 1 or 2 or 3
5. exp Benchmarking/
6. clinical audit/ or exp medical audit/
7. quality assuran*/ or quality improv*/ or benchmark*/ or clinical audit*.tw,kf. or medical audit*.tw,kf.
**HEALTHSTAR**

1. Trauma Centers/
2. (trauma adj (system* or care or network* or health care or model* or center* or centre* or service*)).tw,kf.
3. (injury adj (system* or care or network* or health care or model* or center* or centre* or service*)).tw,kf.
4. 1 or 2 or 3
5. Benchmarking/
6. clinical audit/ or exp medical audit/
7. quality assuran*/ or quality improv*/ or benchmark*/ or clinical audit*.tw,kf. or medical audit*.tw,kf.
8. accreditation/ or certification/ or licensure/
9. (accredited or accreditation).tw,kf.
10. (verified or verification or reverification).tw,kf.
11. "american college of surgeon*".tw,kf.
12. "trauma association of canada".tw,kf.
13. accreditation canada.tw,kf.
14. INESSS.tw,kf.
15. "Institut national d'excellence en santé et en services sociaux".tw,kf.
16. (designated or designation or designate).tw,kf.
17. 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15
18. 4 and 16
19. remove duplicates from 18
CINAHL

<table>
<thead>
<tr>
<th>S1</th>
<th>TI ( trauma N1 (system* or network* or care or &quot;health care&quot; or model* or center* or centre* or service*) ) OR AB ( trauma N1 (system* or network* or care or &quot;health care&quot; or model* or center* or centre* or service*) )</th>
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<tbody>
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<td>TI ( injury N1 (system* or network* or care or &quot;health care&quot; or model* or center* or centre* or service*) ) OR AB ( injury N1 (system* or network* or care or &quot;health care&quot; or model* or center* or centre* or service*) )</td>
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<tr>
<td>S3</td>
<td>S1 OR S2</td>
</tr>
<tr>
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</tr>
<tr>
<td>S5</td>
<td>&quot;&quot;accredited&quot;&quot; OR &quot;accreditation&quot;&quot;</td>
</tr>
<tr>
<td>S6</td>
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<td>&quot;&quot;American College of Surgeons&quot;&quot;</td>
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<tr>
<td>S10</td>
<td>&quot;&quot;Trauma Association of Canada&quot;&quot;</td>
</tr>
<tr>
<td>S11</td>
<td>&quot;&quot;Accreditation Canada&quot;&quot;</td>
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<tr>
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<td>S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13</td>
</tr>
<tr>
<td>S15</td>
<td>S3 AND S14</td>
</tr>
</tbody>
</table>

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((ti(accredited OR accreditation) OR ab(accredited OR accreditation)) OR (ti(verified OR verification OR reverification) OR ab(verified OR verification OR reverification)) OR (ti("clinical audit" OR benchmarking) OR ab("clinical audit" OR benchmarking)) OR (ti("American College of Surgeons") OR ab("American College of Surgeons")) OR (ti("Trauma Association of Canada") OR ab("Trauma Association of Canada")) OR (ti("Institut national d'excellence en santé et en services sociaux") OR ab("INESSS")) OR ab("INESSS")) AND ((ti(trauma NEAR/1 (system* OR network* OR care OR "health care" OR model* OR center* OR centre* OR service*)) OR ab(trauma NEAR/1 (system* OR network* OR care OR "health care" OR model* OR center* OR centre* OR service*)) OR ti(Injur* NEAR/1 (system* OR network* OR care OR "health care" OR model* OR center* OR centre* OR service*)) OR ab(Injur* NEAR/1 (system* OR network* OR care OR "health care" OR model* OR center* OR centre* OR service*))))
List of key injury organisations

The American College of Surgeons, Trauma Association of Canada, International Association for Trauma Surgery and Intensive Care, Australasian Trauma Society, Trauma Audit Research Network, American Association for the Surgery of Trauma, Eastern Association for the Surgery of Trauma, American Trauma Society, British Trauma Society, Orthopaedic Trauma Association, Western Trauma Association, Trauma.org, The Society of Trauma Nurses, International Trauma Anaesthesia and Critical Care Society, BrainTrauma Foundation.
### Supplemental Table S1: Reason for the exclusion of full-text reviewed studies

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Title</th>
<th>Reason for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anonymous, 1988(1)</td>
<td>Pediatric trauma standards: Pennsylvania Trauma Systems Foundation standards for trauma center accreditation</td>
<td>Narrative studies, they listed the standard requirements for pediatrics verification.</td>
</tr>
<tr>
<td>Berk, 1994(2)</td>
<td>Infection control for health care workers caring for critically injured patients: A national survey</td>
<td>Exposure Irrelevant.</td>
</tr>
<tr>
<td>Howell, 1996(3)</td>
<td>Level I trauma certification and emergency medicine resident major trauma experience</td>
<td>Exposure Irrelevant, compared verified Level 1 to all other centers.</td>
</tr>
<tr>
<td>Gagneux, 1998(6)</td>
<td>Trauma emergency unit: long term evaluation of a quality assurance programme</td>
<td>Exposure irrelevant, assessed the effect of a self-established quality assurance program in an emergency department.</td>
</tr>
<tr>
<td>DiRusso, 2001(7)</td>
<td>Preparation and achievement of American College of Surgeons Level I trauma verification raises hospital performance and improves patient outcome</td>
<td>Exposure Irrelevant, assessed preparation to verification.</td>
</tr>
<tr>
<td>Pasquale, 2001(9)</td>
<td>Outcome analysis of Pennsylvania trauma centers: Factors predictive of nonsurvival in seriously injured patients</td>
<td>Exposure Irrelevant.</td>
</tr>
<tr>
<td>Rogers, 2001(10)</td>
<td>Population-based study of hospital trauma care in a rural state without a formal trauma system</td>
<td>Exposure Irrelevant, compared verified Level 1 to non-designated centers.</td>
</tr>
<tr>
<td>Abernathy, 2002(11)</td>
<td>Impact of a voluntary trauma system on mortality, length of stay, and cost at a Level I trauma center</td>
<td>Exposure Irrelevant.</td>
</tr>
<tr>
<td>Ehrlich, 2002(12)</td>
<td>American College of Surgeons, Committee on Trauma verification review: Does it really make a difference?</td>
<td>Exposure irrelevant, assessed preparation to verification.</td>
</tr>
<tr>
<td>Ehrlich, 2002(13)</td>
<td>The need for a statewide pediatric trauma program</td>
<td>Exposure irrelevant.</td>
</tr>
<tr>
<td>Meldom, 2002(14)</td>
<td>Trauma in the very elderly: A community-based study of outcomes at trauma and nontrauma centers</td>
<td>Exposure Irrelevant, compared verified centers to non-designated hospitals.</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Title</td>
<td>Notes</td>
</tr>
<tr>
<td>-----------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Simons, 2002(15)</td>
<td>Relative importance of designation and accreditation of trauma centers during evolution of a regional trauma system</td>
<td>Exposure irrelevant, accreditation occurred after the end of the study.</td>
</tr>
<tr>
<td>Ciraulo, 2004(16)</td>
<td>A survey assessment of the level of preparedness for domestic terrorism and mass casualty incidents among Eastern Association for the Surgery of Trauma Members</td>
<td>Exposure Irrelevant.</td>
</tr>
<tr>
<td>Simons, 2004(17)</td>
<td>Optimising trauma care: Role of trauma systems and trauma centres</td>
<td>Narrative studies.</td>
</tr>
<tr>
<td>Biffl, 2005(18)</td>
<td>The evolution of trauma care at a Level I trauma center</td>
<td>Exposure irrelevant, unable to attribute the change to verification which occurred in 1995 while the post period started in 1999.</td>
</tr>
<tr>
<td>Demetriades, 2005(19)</td>
<td>The effect of trauma center designation and trauma volume on outcome in specific severe injuries</td>
<td>Exposure irrelevant, compared level II verified centers to other verified III or IV and non-verified centers.</td>
</tr>
<tr>
<td>Bowman, 2006(20)</td>
<td>Hospital characteristics associated with trauma outcomes</td>
<td>Exposure irrelevant.</td>
</tr>
<tr>
<td>Eldich, 2006(22)</td>
<td>Level I trauma certification and emergency medicine resident major trauma experience</td>
<td>Narrative studies.</td>
</tr>
<tr>
<td>Nathens, 2006(23)</td>
<td>The delivery of critical care services in US trauma centers: is the standard being met?</td>
<td>Exposure irrelevant, described Intensive Unit Care standards.</td>
</tr>
<tr>
<td>Udekwu, 2006(24)</td>
<td>Trauma Center Designation and Outcomes</td>
<td>Narrative studies, letter to editor.</td>
</tr>
<tr>
<td>Shackford, 2007(25)</td>
<td>The increasing use of vena cava filters in adult trauma victims: data from the American College of Surgeons National Trauma Data Bank</td>
<td>Exposure Irrelevant, all included centers were verified.</td>
</tr>
<tr>
<td>Fang, 2008(27)</td>
<td>Critical care at Landstuhl Regional Medical Center</td>
<td>Narrative studies</td>
</tr>
<tr>
<td>Shafi, 2008(28)</td>
<td>Trauma quality improvement using risk-adjusted outcomes</td>
<td>Exposure irrelevant, compared outcomes among verified ACS centers.</td>
</tr>
<tr>
<td>Terrell, 2008(29)</td>
<td>Nationwide Survey of Alcohol Screening and Brief Intervention Practices at US Level I Trauma Centers</td>
<td>Narrative studies, the part comparing verified to non-verified centers was narrative.</td>
</tr>
<tr>
<td>Author</td>
<td>Title</td>
<td>Exposure Irrelevant, compared Level I versus Level II verified centers.</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
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<tr>
<td>DuBose, 2009</td>
<td>American College of Surgeons trauma centre designation and mechanical ventilation outcomes</td>
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<tr>
<td>Mikhail, 2009</td>
<td>Midlevel practitioner role evolution in an American College of Surgeons-verified trauma surgery service: the 23-year experience at Hurley Medical Center</td>
<td>Narrative studies.</td>
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<tr>
<td>Milham, 2009</td>
<td>Are there racial disparities in trauma care?</td>
<td>Exposure irrelevant, look at outcomes difference due to race irrespective of verification status.</td>
</tr>
<tr>
<td>Nance, 2009</td>
<td>Access to pediatric trauma care in the United States</td>
<td>Exposure irrelevant, assessed access to care.</td>
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<td>Recinos, 2009</td>
<td>ACS trauma centre designation and outcomes of post-traumatic ARDS: NTDB analysis and implications for trauma quality improvement</td>
<td>Exposure Irrelevant, compared Level I versus Level II verified centers.</td>
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<tr>
<td>Ropele, 2009</td>
<td>Cervical spine clearance in the non-alert, non-communicative, or unreliable pediatric blunt trauma patient</td>
<td>Exposure Irrelevant, just described current practices for clearing the cervical spine in a special pediatric population.</td>
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<tr>
<td>Salottolo, 2009</td>
<td>Effects of a nonsurgical hospitalist service on trauma patient outcomes</td>
<td>Exposure irrelevant.</td>
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<tr>
<td>Bennett, 2010</td>
<td>The volume-outcomes relationship for United States level one trauma centers</td>
<td>Duplicate.</td>
</tr>
<tr>
<td>Brown, 2010</td>
<td>Trauma center designation correlates with functional independence after severe but not moderate traumatic brain injury</td>
<td>Exposure Irrelevant, compared Level I versus Level II.</td>
</tr>
<tr>
<td>Cudnik, 2010</td>
<td>Are all trauma centers created equally? A statewide analysis</td>
<td>Exposure irrelevant, all included centers were verified.</td>
</tr>
<tr>
<td>Hemmilia, 2010</td>
<td>The trauma quality improvement program: pilot study and initial demonstration of feasibility</td>
<td>Exposure Irrelevant.</td>
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<td>Bennett, 2011</td>
<td>The volume-outcomes relationship for United States level I trauma centers</td>
<td>Narrative studies, comparison between verified and non-verified centers was a secondary analysis and described narratively.</td>
</tr>
<tr>
<td>Kesler, 2011</td>
<td>Demographic factors and outcomes in patients with epidural hematoma</td>
<td>Narrative studies.</td>
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<tr>
<td>Author</td>
<td>Year</td>
<td>Title</td>
</tr>
<tr>
<td>-----------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
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<td>Plurard</td>
<td>2011</td>
<td>Trauma center designation and the decreasing incidence of post-traumatic acute respiratory distress syndrome: A potential guidepost for quality improvement</td>
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<td>Testerman</td>
<td>2011</td>
<td>Full-time orthopedic traumatologists enhance rural trauma center pelvic fracture outcomes and financials</td>
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<td>Bailey</td>
<td>2012</td>
<td>Verification and Regionalization of Trauma Systems. The Impact of These Efforts on Trauma Care in the United States</td>
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<td>Bukur</td>
<td>2012</td>
<td>The impact of American College of Surgeons trauma center designation and outcomes after early thoracotomy: A national trauma databank analysis</td>
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<tr>
<td>Anonymous</td>
<td>2014</td>
<td>Hasbro designated Level 1 Pediatric Trauma Center by ACS</td>
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<td>Badjie</td>
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<td>Metamorphosis of a massive blood transfusion protocol at a level I trauma center</td>
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<td>Balogh</td>
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<td>Trauma verification: for the trauma centre or for the trauma system?</td>
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<td>Carr</td>
<td>2014</td>
<td>Impact of adding Level II and III trauma centers on volume and disease severity at a nearby Level I trauma center</td>
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<td>Clark</td>
<td>2014</td>
<td>The effect of hospital care on early survival after penetrating trauma</td>
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<td>Guess</td>
<td>2014</td>
<td>Do level I trauma centers address the psychological responses associated with trauma?</td>
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<td>Kim</td>
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<td>Relationship of trauma centre characteristics and patient outcomes: a systematic review</td>
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<tr>
<td>Shafi</td>
<td>2014</td>
<td>Compliance with recommended care at trauma centers: Association with patient outcomes</td>
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<td>Author</td>
<td>Title</td>
<td>Exposure Irrelevant Notes</td>
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<td>Nikolis, 2015</td>
<td>Establishing a massive transfusion protocol (MTP): A collaborative effort</td>
<td>Described an aspect of preparation to verification.</td>
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<td>Santy, 2015</td>
<td>Variations in the implementation of acute care surgery: Results from a national survey of university-affiliated hospitals</td>
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<td>Drefus, 2016</td>
<td>Comparison of pediatric motor vehicle collision injury outcomes at Level I trauma centers</td>
<td>Only verified Level I was included.</td>
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<td>Falcone, 2016</td>
<td>A paradigm for achieving successful pediatric trauma verification in the absence of pediatric surgical specialists while ensuring quality of care</td>
<td>Exposure Irrelevant. They evaluated the impact of the collaborative partnership on improving regional pediatric trauma care</td>
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<td>Grossman, 2016</td>
<td>Effect of American college of surgeons trauma center designation on outcomes: Measurable benefit at the extremes of age</td>
<td>Duplicate. Was an abstract and the full paper was published the next year and included.</td>
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<td>Myers, 2016</td>
<td>A National Analysis of Pediatric Trauma Care Utilization and Outcomes in the United States</td>
<td>Exposure Irrelevant, compared centers regardless of verification status.</td>
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<tr>
<td>Brown, 2017</td>
<td>Impact of Volume Change over Time on Trauma Mortality in the United States</td>
<td>Exposure Irrelevant, assessed the volume outcome relationship</td>
</tr>
<tr>
<td>Joseph, 2017</td>
<td>American College of Surgeons Level I trauma centers outcomes do not correlate with patients’ perception of hospital experience</td>
<td>Exposure Irrelevant, only included verified centers.</td>
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<td>Kaufman, 2017</td>
<td>Triage of injured patients in New York state prior to implementation of the American college of surgeons committee on trauma verification system</td>
<td>Exposure Irrelevant, described triage prior verification.</td>
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<tr>
<td>Bank, 2018</td>
<td>Collaborative implementation of a massive transfusion protocol at a level one trauma center</td>
<td>Exposure irrelevant, they summarized the necessary blood bank resources implemented to ensure successful ACS verification/re-verification.</td>
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<td>Bjurlin, 2018</td>
<td>Impact of Trauma Center Designation and Interfacility Transfer on Renal Trauma Outcomes: Evidence for Universal Management</td>
<td>Exposure irrelevant, only included verified centers.</td>
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<td>Polites, 2018</td>
<td>Undertriage after severe injury among United States trauma centers and the impact on mortality</td>
<td>Exposure irrelevant, the purpose of this study was to determine the undertriage rate between trauma centers. No stratification between ACS and State centers.</td>
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<tr>
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<td>Title</td>
<td>Exposure</td>
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<td>Hamidi, 2019(70)</td>
<td>Outcomes After Massive Transfusion in Trauma Patients: Variability Among Trauma Centers</td>
<td>Exposure irrelevant.</td>
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<td>Spaulding, 2019(71)</td>
<td>Hospital Value-Based Purchasing and Trauma-Certified Hospital Performance</td>
<td>Exposure irrelevant, compared trauma centers to non-trauma centers.</td>
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<td>Swartz, 2019(72)</td>
<td>Geriatric trauma collaboration: Feasibility, sustainability and improved outcomes</td>
<td>Exposure irrelevant.</td>
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<td>Ukwuoma, 2019(73)</td>
<td>Does an Emergency Department Trauma Status Upgrade Impact the Timeliness of Nontrauma Computed Tomography Scans</td>
<td>Irrelevant, non-trauma patients.</td>
</tr>
</tbody>
</table>

**References**

20. Bowman SM. Hospital characteristics associated with trauma outcomes. 2006(3224190):77.


50. A. Hasbro designated Level 1 Pediatric Trauma Center by ACS. 2014;97(5):64.
### Supplemental Table S2: GRADE evidence profile: Effectiveness of trauma center verification

<table>
<thead>
<tr>
<th>Quality assessment</th>
<th>Number of findings</th>
<th>Absolute risk</th>
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<tbody>
<tr>
<td></td>
<td>No of Studies</td>
<td>Limitations</td>
</tr>
<tr>
<td><strong>Hospital Mortality (number of studies)</strong></td>
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<tr>
<td>All patients (1)</td>
<td>Serious</td>
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</tr>
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<td>Pediatrics (2)</td>
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<td>Level I (3)</td>
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<td>Serious</td>
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<tr>
<td>Level II (1)</td>
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</tr>
<tr>
<td>Other (2)</td>
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<td><strong>Length of Stay (number of studies)</strong></td>
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<td>Overall (1)</td>
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<td>Overall Level I (4)</td>
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</tr>
<tr>
<td>Overall Level II (1)</td>
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<td>Overall Sub-population (4)</td>
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<td>Serious</td>
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<tr>
<td>ICU Level I (2)</td>
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<td>No Serious</td>
</tr>
<tr>
<td>ICU Sub-population (2)</td>
<td>Serious</td>
<td>No Serious</td>
</tr>
</tbody>
</table>

*There is minor indirectness of the interventions due to comparison groups

¥Exponentiate of weighted mean differences can be interpreted as geometric mean ratio

N.A: Not Applicable; OR: Odds Ratio; WMD: Weighted mean difference