Validation of ICMED:
The International Crowding Measure in Emergency Departments

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About the project:

- International cross-sectional study comprising seven EDs in 5 countries
- REB approved, no conflicts of interest to declare
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Overview

- **Background**

- **Methods**

- **Results**

- **Conclusion**
Rationale: Why is ED crowding important?

- It’s a worldwide problem
- It increases patient morbidity & mortality
Rationale: Why is ED crowding important?

“Boarding” in the ED:
- ie a patient admitted hospital who remains in the ED.\(^4\)
- Elderly and frail patients more likely to board.\(^3,4\)
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Rationale

*How can we measure emergency department crowding?*

- At least eight such scales exist.\(^3,4\)
- **EDWIN** (Emergency Department Work Index)\(^6\)
- **NEDOCS** (National Emergency Department Overcrowding Score).\(^7\)
- Measure whether crowding present
- Less capable of measuring the effect that crowding is having on the function of the department and implement interventions to counteract
Rationale

How do we measure ED crowding locally in New Brunswick?

- **ED Saturation Level Calculator:**
  - Three calculators: Saint John, Moncton, Fredericton.
  - Based on the NEDOCS tool, more extensive
  - When saturated, Overcapacity Protocol initiated (“Code Orange”)
  - Face validity locally but not formally validated
  - Not able to identify the cause of crowding
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Rationale

How can we measure emergency department crowding?

- Three general themes have emerged as causative factors.2,3,4
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Rationale

So why study emergency department crowding?

- Identifying when crowding is present or imminent is paramount to prevent the harm caused by ED crowding.

- If the cause of crowding is identified, may enable solutions to the crowding.¹
METHODS
Methodology

What is the ICMED?

- Eight-point measure of ED crowding
- Utilizes input, throughput and output measures
- Derived via a three-round Delphi study of 40 professionals with expertise in ED crowding
- Previously validated in the UK
What is the ICMED?

- Designed to measure whether crowding is present
- Identify the cause of crowding
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The ICMED Tool:

**Input measures**

1. Ambulance offload time
   An ED is crowded when the 90th percentile time between ambulance arrival and offload is greater than 15 minutes.

2. Patients who LWBS
   An ED is crowded when number of patients LWBS is greater than or equal to 15%.

3. Time Until Triage
   An ED is crowded when there is a delay greater than 5 minutes from patient arrival to begin their initial triage.
## Throughput measures

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4. ED Occupancy</strong></td>
<td>An ED is crowded when the occupancy rate is greater than 100%</td>
</tr>
<tr>
<td><strong>5. Total LOS</strong></td>
<td>An ED is crowded when the 90\textsuperscript{th} centile patient total length of stay is greater than 4h.</td>
</tr>
<tr>
<td><strong>6. Time to Physician assesss.</strong></td>
<td>An ED is crowded when a Triage Level 1 or 2 patient waits greater than 30 min to be seen by a physician.</td>
</tr>
</tbody>
</table>
## Output measures

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>ED Boarding time</td>
<td>An ED is crowded when less than 90% of patients have left the ED 2h after the admission decision.</td>
</tr>
<tr>
<td>8.</td>
<td>Number of patients boarding in ED</td>
<td>An ED is crowded when there is greater than 10% occupancy of boarders in the ED.</td>
</tr>
</tbody>
</table>
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Methodology

Research Question:

- Is the ICMED tool a valid measure of emergency department crowding, when compared to the clinical perception of senior physicians?

- Aim to validate ICMED in an international sample of EDs
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Methodology

- **Predictor variable: sICMED**
  - Modified seven-point ICMED scale (modified a priori)
  - Does not capture patients who LWBS as this was found to be too difficult to capture in real time
  - Scored from 0 to 7, one point for each violation
Methodology

Seven sites:
1. Cambridge, UK
2. Derriford, UK
3. Dublin, Ireland
4. Santiago, Chile
5. San Diego, California, USA
6. Newmarket ON, Canada
7. Saint John NB, Canada
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Methodology

- **Outcome measure**: physician rating, based on 10cm VAS.

- Clinician rating the standard of face validity in ED crowding, based on previous research for EDWIN and NEDOCS

- Two 10 cm VAS: 1) Crowding and 2) Danger
Methodology

Charge Physician VAS:

A1: Clinician Perception of Crowdedness VAS

Indicate on this line how crowded you think this Emergency Department is at this moment

Not Crowded  ____________________________________________  Very Crowded

A2: Clinician Perception of Safety VAS:

Indicate on this line how unsafe you think the Emergency Department is at this moment

Very Safe  ____________________________________________  Very Unsafe
Methodology

- **Sample size calculation:**
  - Pilot work suggested that around 350 observations would be required to account for clustering.
  - 40 entries required from each centre
Results

- Total 398 observations were collected between February and November 2014

- 99% data completeness (4 entry excluded due to incomplete data)

- Measurements taken at variable intervals (1 to 4 hours)

- Results sheets scanned and emailed to chief investigator in UK
Results

- Linear regression was used to assess associations, and intra-site clustering was assessed with clustered robust standard errors.

- Two outcome variables: visual analogue scale for clinical perception of crowding and safety
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The mean sICMED scores varied across centres:

<table>
<thead>
<tr>
<th>Centre</th>
<th>Mean sICMED Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santiago, Chile</td>
<td>0.8</td>
</tr>
<tr>
<td>Derriford UK</td>
<td>2.8</td>
</tr>
<tr>
<td>San Diego USA</td>
<td>2.8</td>
</tr>
<tr>
<td>Saint John NB</td>
<td>3.3</td>
</tr>
<tr>
<td>Newmarket ON</td>
<td>3.3</td>
</tr>
<tr>
<td>Cambridge UK</td>
<td>3.7</td>
</tr>
<tr>
<td>Dublin, Ireland</td>
<td>6.9</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Centre</th>
<th>Correlation to perception of:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crowding</td>
<td>Danger</td>
<td></td>
</tr>
<tr>
<td>Santiago, Chile</td>
<td>0.41</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>Derriford UK</td>
<td>0.62</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>San Diego USA</td>
<td>0.60</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>Saint John NB</td>
<td>0.32</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>Newmarket ON</td>
<td>0.19</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>Cambridge UK</td>
<td>0.76</td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td>Dublin, Ireland</td>
<td>0.006</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td><strong>All Centres</strong></td>
<td><strong>0.42</strong></td>
<td><strong>0.47</strong></td>
<td></td>
</tr>
</tbody>
</table>
### The clustered linear regression coefficients are reported below:

<table>
<thead>
<tr>
<th>Predicting perception of:</th>
<th>Coefficient of</th>
<th>Standard Error</th>
<th>95% CI</th>
<th>p value</th>
<th>R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crowding</td>
<td>0.364</td>
<td>0.07</td>
<td>0.170-0.559</td>
<td>0.004</td>
<td>0.246</td>
</tr>
<tr>
<td>Danger</td>
<td>0.306</td>
<td>0.026</td>
<td>0.050-0.563</td>
<td>0.008</td>
<td>0.220</td>
</tr>
</tbody>
</table>
Limitation:

- **No gold standard in the evaluation of ED crowding**
  - ED clinician opinion is a consistently utilized soft criterion standard in multiple previous studies and is a practical choice.
Conclusions:

- Overall, the siCMED was moderately correlated with the perceptions of crowding and danger, $r=0.42$ and 0.47.

- There was substantial variability in the performance of the siCMED in different countries and different centres.
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Conclusions:

- The sICMED was better than individual component variables at predicting clinician’s concerns about crowding or danger.

- In particular, the sICMED was better at predicting clinician’s perceptions than was presence of >100% occupancy alone.
Conclusions:

- This study provides some face validity for the sICMED as a measurement tool of emergency department crowding in some, but not all settings.

- Future work should validate the sICMED against harder outcomes such as cancelled elective surgery and mortality.
RESEARCH: Emergency Department Crowding Scores

Potential impact:

- An ideal tool would be:
  - Calculated quickly in real time using electronic data
  - Determine why crowding is occurring (input, throughput, output)
  - Allow real time implementation of multiple interventions to relieve crowding

$ICMED$ shows face validity in achieving these goals
RESEARCH: Emergency Department Crowding Scores

References

Questions?