Population risk stratification in outcome analysis - approaches and innovative solutions

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“Risk Stratification is one part of a complex process that utilises and optimises technology to provide a prompt for action, and a way of thinking about care delivery and the patient experience”

1 Risk Stratification - A discussion paper for NSW Health’s approach to Risk Stratification, 19th December 2014 Agency for Clinical Innovation
Risk Stratification Tools and Models

- Clinician prediction
- Disease based Risk Stratification
- Criteria based or Threshold Based Risk Stratification
- Predictive modelling
Available Tools for Risk Stratification

Acute settings and Primary Care

- CHADS (Congestive heart failure, Hypertension, Age >75 years and Diabetes, prior Stroke). CHADS is an example of a condition specific tool which identifies a cohort at risk of stroke using the specific criteria above.

- PRISM (Predictive Risk Stratification Model) has been developed for general practice that estimates risk of an emergency hospital admission in the following year.

- The (CPD) Combined Predictive Model supplements PARR (Patients at Risk of Readmission) data with data from outpatient, emergency departments and General Practice. The CPD makes predictions based on the entire population. The broad application of the CPD is that it allows segmentation of an entire population into relative risk segments.
Available Tools for Risk Stratification

- **EARLI (Emergency Admission Risk Likelihood Index)**
  - This is a UK tool for use in Primary Care and is a 6 item questionnaire developed from data from patients aged over 75 years.
  - Prospective cohort study of older people registered with 17 general practices within Halton Primary Care Trust in the north-west of England.
  - EARLI can be used as a simple triage-screening tool to identify the most vulnerable older people, either to target interventions and support to reduce demand on hospital services.

- **PEONY (Predicting Emergency Admissions Over the Next Year)**
  - A UK tool for use in Primary Care for those aged 40-65 years that is able to predict future emergency admissions in all individuals 40 years or older.
  - Historical cohort observational study from 1996 to 2004 with at least 1 year of follow-up and split-half validation, set in the population of Tayside, Scotland (n = 410 000).

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Qadmissions

- A real time risk prediction tool that calculates an individual’s risk of emergency admission over the next 1-2 years at the point of care.

- It can also be collected through review of GP data systems.

- This is a validated tool for use in the UK.

The predicted and observed risks of emergency admission at 2 years across each 10th of the predicted risk (1 representing the lowest risk and 10 the highest risk)4

HES (Hospital Episode Statistic)

4 Figure 1 in Hippisley-Cox and Coupland (2013) Predicting risk of emergency admission to hospital using primary care data: derivation and validation of QAdmissions score. BMJ Open 3(8): e003482.
Available Tools for Risk Stratification

Other clinical risk prediction tools have been derived from the QResearch database:

**Predicting risk of Type II Diabetes in England and Wales (the QDscore)**

- The QDScore is the first risk prediction algorithm to estimate the 10 year risk of diabetes on the basis of a prospective cohort study and including both social deprivation and ethnicity.
- It was designed so that it would be based on variables that are readily available in patients’ electronic health records or which patients themselves would be likely to know.
- The QDScore algorithm does not need laboratory tests and can be used in clinical settings.
- It offers ease of use as it can also be used by the public through a simple web calculator (www.qdscore.org).

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Available Tools for Risk Stratification

Predicting risk of Type II Diabetes in England and Wales (the **QDscore**)

- The QDscore model includes both deprivation and ethnicity as well as age, sex, smoking, treated hypertension, body mass index, family history of diabetes, current treatment with corticosteroids, and previous diagnosis of cardiovascular disease.
- Inclusion of both deprivation and self-assigned ethnicity, are important factors independently associated with risk of diabetes.

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**HES (Hospital Episode Statistic)**

Available Tools for Risk Stratification

Predicting risk of Type II Diabetes in England and Wales (the QDscore) - Limitations

• The main outcome was type 2 diabetes diagnosed by a clinician and recorded on the clinical computer system.

• The outcome was not formally validated, and the study did not use the results of laboratory tests to confirm the diagnosis (however, the diagnosis would be unlikely to be recorded if the patient did not have diabetes).

• A degree of over-optimism could exist as, although the study used a completely physically discrete set of general practices for the validation, these practices use the same clinical computer system (EMIS) as those used to derive the algorithm.

• However, this system is at present in use in 60% of UK general practices, so the QDscore diabetes clinical risk algorithm is at least likely to perform well for well over half of the UK’s population.
Available Tools for Risk Stratification

- At present, no such tools are in common use in psychiatry.

- This is in stark contrast to other areas of medicine, such as diabetes oncology and cardiology.

- Suicidal ideation occurs in more than 10% of the population during their lifetime.

- Suicide does not happen without warning and people make contact frequently with primary care services in the months and weeks leading up to their suicide attempt.

- There is pressing need to identify those at risk for targeted interventions to prevent suicide before it occurs.
• One Australian study\textsuperscript{7} examined a large pool of factors that are potentially associated with suicide risk from the comprehensive electronic medical record (EMR) and to derive a predictive model for 1–6 month risk.

• 7,399 patients undergoing suicide risk assessment were followed up for 180 days.

• The dataset was divided into a derivation and validation cohorts of 4,911 and 2,488 respectively. Clinicians used an 18-point checklist of known risk factors to divide patients into low, medium, or high risk.

• Their predictive ability was compared with a risk stratification model derived from the EMR data.

• The model was based on the continuation-ratio ordinal regression method coupled with lasso (least absolute shrinkage and selection operator).

\textsuperscript{7} Tran et al. (2014) Risk stratification using data from electronic medical records better predicts suicide risks than clinician assessments. BMC Psychiatry. 14:76
Risk scores from the 18-point risk assessment instrument with respect to 90-day outcomes from Tran et al. (2014) are shown below:

<table>
<thead>
<tr>
<th>Item</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suicidal ideation</td>
<td>1.08</td>
<td>1.08</td>
<td>1.30</td>
</tr>
<tr>
<td>Suicide plan</td>
<td>1.04</td>
<td>1.05</td>
<td>1.25</td>
</tr>
<tr>
<td>Access to means</td>
<td>1.15</td>
<td>1.22</td>
<td>1.39</td>
</tr>
<tr>
<td>Prior attempts</td>
<td>1.26</td>
<td>1.34</td>
<td>1.70</td>
</tr>
<tr>
<td>Anger/Hostility/Impulsivity</td>
<td>1.27</td>
<td>1.38</td>
<td>1.42</td>
</tr>
<tr>
<td>Depression (current level)</td>
<td>1.29</td>
<td>1.26</td>
<td>1.40</td>
</tr>
<tr>
<td>Anxiety</td>
<td>1.37</td>
<td>1.33</td>
<td>1.44</td>
</tr>
<tr>
<td>Disorientation/Disorganisation</td>
<td>1.04</td>
<td>1.14</td>
<td>1.08</td>
</tr>
<tr>
<td>Hopelessness</td>
<td>1.30</td>
<td>1.32</td>
<td>1.51</td>
</tr>
<tr>
<td>Identifiable stressors</td>
<td>1.61</td>
<td>1.62</td>
<td>1.67</td>
</tr>
<tr>
<td>Substance abuse</td>
<td>1.22</td>
<td>1.56</td>
<td>1.44</td>
</tr>
<tr>
<td>Psychosis</td>
<td>1.01</td>
<td>1.13</td>
<td>1.04</td>
</tr>
<tr>
<td>Medical status</td>
<td>1.20</td>
<td>1.34</td>
<td>1.35</td>
</tr>
<tr>
<td>Withdrawal from others</td>
<td>1.20</td>
<td>1.24</td>
<td>1.21</td>
</tr>
<tr>
<td>Expressed communication</td>
<td>1.08</td>
<td>1.19</td>
<td>1.21</td>
</tr>
<tr>
<td>Psychiatric service history</td>
<td>1.08</td>
<td>1.23</td>
<td>1.21</td>
</tr>
<tr>
<td>Coping strategies</td>
<td>1.25</td>
<td>1.40</td>
<td>1.51</td>
</tr>
<tr>
<td>Supportive others (connectedness)</td>
<td>1.35</td>
<td>1.45</td>
<td>1.56</td>
</tr>
</tbody>
</table>

Table 4 in Tran et al. (2014). Risk stratification using data from electronic medical records better predicts suicide risks than clinician assessments. BMC Psychiatry. 14:76
The clinician prediction had relatively low predictive ability with ROCs of 0.55 to 0.59 over the four time points when predicting high-risk events.

- ROCs for the EMR model were consistently better, ranging from 0.73 to 0.79.

- Similar differentials were also observed when predicting either moderate or risk events, where the ROC were in the range 0.52 - 0.54 for clinicians and 0.71 - 0.79 for EMR models.

<table>
<thead>
<tr>
<th>Area under the ROC curve (AUC, 95% CIs) of clinicians versus EMR-based model on the validation cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinician</strong></td>
</tr>
<tr>
<td>High-risk versus the rest</td>
</tr>
<tr>
<td>30 days</td>
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<tr>
<td>60 days</td>
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<tr>
<td>90 days</td>
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<tr>
<td>180 days</td>
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<tr>
<td>Moderate/high-risk versus low-risk</td>
</tr>
<tr>
<td>30 days</td>
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<tr>
<td>60 days</td>
</tr>
<tr>
<td>90 days</td>
</tr>
<tr>
<td>180 days</td>
</tr>
</tbody>
</table>

Table 5 in Tran et al. (2014). Risk stratification using data from electronic medical records better predicts suicide risks than clinician assessments. BMC Psychiatry. 14:76
Suicidality: Treatment Occurring in Paediatrics

The overarching long term goal of the STOP project was to develop a stand-alone, comprehensive HealthTracker™ based assessment for the longitudinal monitoring of suicidality and its mediators in children and adolescents.

This was achieved through the STOP Suite of Suicidality Measures that was developed on the HealthTracker™ platform.
Summary

- Risk models rely on different sets of criteria to indicate risk.

- Real time identification (using risk prompts or flags together) in combination with case findings (using predictive models and software platforms to create tool(s) whereby risk factors are captured) can improve the accuracy of risk stratification.

- The HealthTracker™ based STOP Suite of Suicidality Measures allowed for predictive modelling to be performed and collectively led to the development of the single HealthTracker™ based scale for risk stratification in suicidality.

- The developed HealthTracker™ based suicidality scale can be used as a stand-alone single scale for pharmacovigilance whenever a new drug is introduced in children and adolescents (or for that matter in adults) so that medication related suicidality can be prospectively monitored.