Review of the NICOR processes for detection of outliers

Background

The National Institute for Cardiovascular Outcomes Research (NICOR) was formed in 2011, bringing together the six main national cardiovascular audits:

<table>
<thead>
<tr>
<th>Audit</th>
<th>Professional Society(ies)</th>
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<tr>
<td>National Congenital Heart Disease Audit (NCHDA)</td>
<td>British Congenital Cardiac Association (BCCA); Society for Cardiothoracic Surgery in Great Britain and Ireland (SCTS)</td>
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<td>Myocardial Ischaemia National Audit Project (MINAP)</td>
<td>British Cardiovascular Society (BCS)</td>
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<td>National Audit of Percutaneous Coronary Intervention (NAPCI)</td>
<td>British Cardiovascular Intervention Society (BCIS)</td>
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<tr>
<td>National Adult Cardiac Surgery Audit (NACSA)</td>
<td>Society for Cardiothoracic Surgery in Great Britain and Ireland (SCTS)</td>
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<td>National Heart Failure Audit (NHFA)</td>
<td>British Society for Heart Failure (BSH)</td>
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<tr>
<td>National Audit of Cardiac Rhythm Management (NACRM)</td>
<td>British Heart Rhythm Society (BHRS)</td>
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The audits are commissioned by the Healthcare Quality Improvement Partnership (HQIP) and funded by NHS England and GIG/Cymru NHS Wales and, for some audits, NHS Scotland. Funding for participation from Health and Social Care in Northern Ireland and the private sector is being sought.

The UK Transcatheter Aortic Valve Implantation (UK TAVI) Registry was developed in 2007/08 and is also managed by NICOR.

The individual sub-specialty (‘domain’) registries had been developed by the relevant professional societies and in the late 1990s/early 2000s, individual patient records were captured through the Central Cardiac Audit Database (CCAD). The database was incorporated into NICOR in 2011.

NICOR was initially hosted at University College London (UCL). Progress was made in the way that data were collected and analysed, annual reports were prepared and there was development of a number of feedback systems to the hospitals participating in the audit. The audits have many functions, including quality assurance and quality improvement within the health services but they also provide a historical review of the management of cardiovascular conditions over time, and the collated data are available for observational research. In 2017, NICOR moved and is now hosted by the Barts Health NHS Trust.

Risk models and comparative assessment of hospitals and individual operators

To assess how a hospital or even an individual operator is performing, one could simply assess raw outcomes (such as mortality following a procedure) against the national observations. However because of differences in case mix at different centres or by different operators, adjustment is needed to try to compare like with like, and so provide for a more accurate assessment of comparative performance. Risk models have been developed and published that are good at
accounting for differences in case mix. Examples include EuroSCORE and iterations for cardiac surgery, a 30 day mortality model following PCI based on UK data, and a 30 day mortality model following TAVI.

These models have good calibration and discrimination when assessing overall outcomes of populations, but there are complexities when they are used to try to compare outcomes by centre or by operator, and particularly when they are used to try to find outlier performance. NICOR developed statistical methods for comparative outcome analysis working closely with the specialist societies and taking detailed advice from both Professor Sir David Spiegelhalter, University of Cambridge, and also from Professor Sir Nick Black, Professor of Health Services Research at the London School of Hygiene and Tropical Medicine. The SCTS led the way in publishing risk-adjusted outcomes for every cardiac surgeon in the UK.

In 2013, the then-NHS Medical Director, Sir Bruce Keogh (who had worked with Professor Ben Bridgewater and others on developing the SCTS programme) launched the Clinical Outcomes Publication (COP) programme, to be used for 10 specialties (now 24). This was an NHS England initiative, managed by HQIP. HQIP has provided additional guidance on the methodology.1,2

As part of a governance review in 2015/16, NICOR was recommended to review the statistical processes being used for the detection of outliers. NICOR therefore invited the Department of Statistical Science at UCL, led by Professor Rumana Omar, to lead a statistical review of the methodology and the coding required for analysis. As of 2019 this work is on-going and has been led by Professor Omar, Dr Gareth Ambler, Senior Lecturer at the UCL DSS, and Dr Menelaos Pavlou, Lecturer at the UCL DSS.

Statistical methodology

Understanding variation in performance in clinical specialties is complex, and there is no one accepted standard methodology. The methods previously used were based on funnel plot analysis, where the observed outcomes were compared with expected outcomes, while accounting for case mix and random variation. With small numbers of procedures the statistical variation in observed outcomes is greater than with large volumes, and this accounts for the funnel shape of the outlier boundaries when volume is plotted against outcome.

There are several recognised limitations of this method. These include ‘over-dispersion’ – when the observed variation (and hence scatter on the plot) is larger than would expected from a binomial distribution. There is also difficulty in making multiple comparisons - if you compare enough observations you would expect to incorrectly identify an outlier by statistical chance. Models also tend to drift with time so, for example, EuroSCORE started over-predicting risk soon after it was published. There are also issues with clustering, where the difference between centres’ case mix will interact with the differences in operator outcomes between centres.

Many of these problems can be addressed by random effects modelling, a technique that has only become possible as computing power has increased in recent years. These new methods have also been recommended by Prof David Spiegelhalter and others. While it successfully addresses several methodological issues, the results of analysis are not well suited to display in a familiar funnel plot,
and so we are developing new ways to display data, to try to maintain some intuitive appreciation of the information without misleading the observer.

Having done a full literature search on the methodology, Dr Pavlou and colleagues have developed a statistical process to incorporate this methodology into the NICOR datasets. A review was made into the coding of the method into the programmes that run the analyses. These methods have now been incorporated into the NICOR NACSA and NAPCI datasets to produce the COP results. The method will also be applied to all similar analyses where risk-adjusted outcomes will be assessed, whether at hospital- or individual operator-level. In addition this has been incorporated into the NICOR Standard Operating Procedure for detection of outliers.3

Attached is a presentation by Dr Pavlou which covers some of the background and development of these methods and an example of the plots with explanatory notes is provided.

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References

3. NICOR Standard Operating Policy: NCAP Outlier Policy, version 5, 24th June 2019