Institution: Queen Mary University of London (QMUL)

Unit of Assessment: A2 (Public Health, Health Services Research and Primary Care)

Title of case study: Implementation of QRisk tool for cardiovascular risk management

1. Summary of the impact

QRisk is a statistical model / score derived from routine general practice (GP) records to calculate an individual's risk of developing cardiovascular disease (CVD). Queen Mary researchers formed the London arm of a multi-centre study and were particularly instrumental in testing the tool in general practice. QRisk targets treatment more effectively than other scores; it is also more equitable for disadvantaged and minority ethnic groups and cheaper per event prevented. QRisk is used in the NHS Health Checks programme covering 20 million people in England and is available at a keystroke in all GP computer systems in England. It has contributed to the identification of an additional 2.8 million people in England at high risk of CVD and their treatment with statins, reducing CVD deaths and events by an estimated 9,000 per year – about 50,000 to date since the NHS Checks programme started in 2009.

2. Underpinning research

The epidemic of premature CVD mortality (under 75 years old) peaked in the 1970s, declining from 250 per 100,000 to 50 per 100,000 in 2010. But ethnic and socio-economic differences in CVD risk have persisted. It has been possible for many years to estimate a person's CVD risk, calculated from paper look-up tables based on Framingham data. In 1997, Dr Robson (based at Queen Mary throughout) implemented the first UK electronic version of a CVD risk score (Framingham) on the leading GP computer system (EMIS), which allowed GPs to use two keystrokes for an 'automated' risk score. However, the Framingham score was derived from research undertaken in the 1970/80s in one small, relatively affluent and largely white US town. Framingham score substantially overestimates overall UK CVD risk and underestimates this risk in South Asian and socially disadvantaged people.

Inaccurate estimates lead to poorly targeted interventions, including lifetime statin treatment, and impact on equitable provision and outcomes. The Framingham score targets 3 million people in England for preventive therapy while QRisk targets 2 million more accurately. QRisk identifies 300,000 people who would miss out on treatment if CVD risk were calculated with Framingham score, many of whom are South Asians and / or in socio-economically disadvantaged groups.

QRisk: In 2004-08, the NICE guideline development group CG67, chaired by Dr Robson, reviewed risk scores including Framingham, and identified the need to develop more contemporary scores that included minority ethnic groups, social disadvantage and family history of premature CVD [1]. In 2007, Dr Robson worked with Prof Hippisley-Cox's team in Nottingham to develop QRisk [2-4]. This was the first use of routine GP records for risk prediction and the first to include socio-economic status. The tool was validated in an internal subset and an independent external dataset. QRisk reallocates treatment assignment in 1/3 of those who would previously have been identified at high risk (1.3 million individuals), impacting significantly on individuals, equity and resource use.

Validation: An international statistical and epidemiological panel commissioned by NICE including Peto (Oxford) and Jackson (New Zealand) recommended use of QRisk to the NICE guideline group. Despite this, the group initially failed to reach agreement on QRisk. In 2008, a third independent validation, carried out by Collins and Altman at DOH's request, confirmed the methods, validation and superiority of QRisk compared to the historically popular Framingham score [6,7]. In 2008, a refined version of the score, QRisk2, was accepted as a major improvement and the first independently validated score to include ethnic group. An updated version was developed in 2010 [5] and externally validated in 2012 [8].

Updating: To avoid overestimation, the QRisk score equation is regularly updated and modified using accessible real-time GP data – important to maintain accurate prediction given continuing

changes in population behaviour (smoking/diet) and falling trends in CVD risk. It also allows periodic statistical refinements to the score (eg addition of new components, revisions in the weightings assigned to each component). In contrast, the Framingham score, based on an historical cohort, has led to major inaccuracy in contemporary European populations.

The team that developed QRisk included the following academics:
Prof J Hippisley-Cox (U of Nottingham). Director QResearch clinical database. QRisk team leader
Dr J Robson (QMUL). Academic GP and health services researcher
Dr P Brindle (Avon Primary Care Research Collaborative). General Practitioner
C Coupland Y Vinogradova (U of Nottingham). Statisticians
Prof A Sheikh, University of Edinburgh. Academic GP and health services researcher

Dr Robson [a] chaired the NICE guideline group that originally identified the need to improve risk tools for general practice; [b] tested existing tools in GP computer systems in east London as a preliminary phase to the QRisk research; [c] helped develop and validate QRisk; [d] provided unique input to the QRisk team as a GP academic with specific expertise in the installation and implementation of computerised risk scores in the community-based clinical setting across a socio-economically deprived district; and [e] played an active role in implementing QRisk locally (to demonstrate real-world feasibility) and nationally (through the EMIS user group and otherwise). Funding was from local NHS trusts, Queen Mary, and Universities of Nottingham and Edinburgh.

3. References to the research on QRisk undertaken by the QMUL team

1. NICE Guidance CG67. Cooper A, Nherera L, Calvert N, O'Flynn N, Turnbull N, Robson J, *et al*. Clinical guidelines and evidence review for lipid modification, cardiovascular risk assessment and the primary and secondary prevention of cardiovascular disease. NCCP. London: Royal College of General Practitioners; 2008.
2. Hippisley-Cox J, Coupland C, Vinogradova Y, **Robson J**, May M, Brindle P. Derivation and validation of QRISK, a new cardiovascular disease risk score for the United Kingdom: prospective open cohort study. *BMJ* 2007;335:136.
3. Hippisley-Cox J, Coupland C, Vinogradova Y, **Robson J**, Brindle P. Performance of the QRISK cardiovascular risk prediction algorithm in an independent UK sample of patients from general practice: a validation study. *Heart* 2008; 94: 34-9.
4. Hippisley-Cox J, Coupland C, Vinogradova Y, **Robson J**, Minhas R, Sheikh A, et al. Predicting cardiovascular risk in England and Wales: prospective derivation and validation of QRISK2. *BMJ* 2008;336:1475-82.
5. Hippisley-Cox J, Coupland C, **Robson J**, Brindle P. Derivation, validation, and evaluation of a new QRISK model to estimate lifetime risk of cardiovascular disease: cohort study using QResearch database. *BMJ* 2010; 341: c6624.

Independent validation studies on QRISK by external experts

6. Collins GS, Altman DG. An independent external validation and evaluation of QRISK cardiovascular risk prediction: a prospective open cohort study. *BMJ* 2009; 339: b2584.
7. Collins GS, Altman DG. An independent and external validation of QRISK2 cardiovascular disease risk score: a prospective open cohort study. *BMJ* 2010; 340: c2442.
8. Collins GS, Altman DG. Predicting the 10-year risk of cardiovascular disease in the United Kingdom: independent and external validation of an updated version of QRISK2. *BMJ* 2012; 344: e4181.

4. Details of the impact

QRisk had an impact in five areas: implementation and use of QRisk in UK primary care (GP surgeries and pharmacies); direct uptake and use by the public and patient organisations; informing policy on NHS Health Checks; informing methodological work on risk score development and validation; and inspiring further research on the use of QRisk-type scores for other chronic conditions. We consider these in turn below.

4a: Implementation and routine use of QRisk in UK primary care

The success of QRisk has depended both on its robust scientific basis and on intensive efforts on the implementation of the score in front-line general practice. The effort included:

- Dr Robson worked with the GP system supplier EMIS to ensure that the risk score was fully integrated in GP computer software to give a 'one-click' QRisk calculation covering 55% of the English population.
- An accessible website (www.qrisk.org) including a user-friendly risk calculator aimed at both health professionals and the public. The website currently receives ~25,000 visits per month (around 2 million visits to date).
- Dr Robson advised the DH and a London-wide team on QRisk implementation. Locally in east London, he was a member of the North East London Cardiac Network Board, CVD lead for Tower Hamlets PCT and advisor to other local PCTs in east London.

Using QRisk rather than Framingham as the risk score on GP computer systems is more equitable for the needs of high risk ethnic minorities, the socially disadvantaged and is estimated it will prevent 3,000 more CVD events in five years in those at high risk in England because QRisk identifies a risk group that is on average, at higher risk than that those identified by Framingham. In people found to be at high CVD risk, events will be further reduced by targeting treatment for high blood pressure and earlier identification of diabetes.

Dr Robson collaborated with Prof Hippisley-Cox to design the QRisk calculator and website and worked with EMIS, the largest UK computer supplier to integrate QRisk in their electronic record using minimal additional data and no duplicated entry. This was complex, requiring automated on-line real-time connection to a remote 'cloud' calculator, which returns the score to the GP record within milliseconds in a seamless electronic tool for busy clinicians and their patients in the consulting room. An app is now available. The new QRisk-lifetime score was presented by the Joint British Societies to replace the previous Framingham score as their preferred risk engine [9].

QRisk has now been implemented by all GP system suppliers in England and Wales. Other system suppliers use QRisk in community and pharmacy contexts including Oskis, Wellpoint (kiosk/pharmacies), Telehealth (kiosk/pharmacies), Cumbria Mental Health Trust, Informatica, Health Diagnostics and Health Smart. These pharmacy and other community schemes use QRisk as part of the NHS Health Checks programme (see below).

By 2011 the NHS Health Checks programme had identified 2.8 million people at high CVD risk who have been started on statins – most of whom are likely to have been identified with QRisk (as EMIS covers 60% of GP practices and QRisk is implemented on all other major computer systems) – though some will have been identified with Framingham. As statins reduce CVD events by 25% and the average risk of those identified is around 10%, it is estimated that this programme is preventing 9,000 CVD deaths or events every year – about 50,000 since the programme started in 2009. This is a major public health achievement [10].

4b: Uptake and use by the lay public and patient organisations
A key aspect of the QRisk website is that it can be used by an untrained layperson to calculate their own cardiovascular risk, allowing self-diagnosis and prompting people to attend their GP or pharmacist for further investigation and advice. Public dissemination has been extensive and QRisk is included on a number of websites including Patient UK, National Prescribing Centre, NHS Health Check and NHS Improvement websites. It was endorsed by the Director of the British Heart Foundation and is included in their factsheets. The QRisk website is now being accessed about 300,000 times a year, including 40,000 visits from outside the UK.

4c: Informing policy on NHS health checks
Dr Robson has been an advisor to the Department of Health on NHS Health Checks and a member of the London NHS Health Checks Implementation Group. The NICE guideline [1 above], chaired by Dr Robson, provided the scientific rationale and recommendation that underpinned the 2009 national NHS Health Checks programme, which offers cardiovascular risk assessment to all adults aged 40-74 years in England. On publication of NICE guidance in 2007, the Department of Health endorsed QRisk for CVD risk estimation in its NHS Checks programme [11,12] and used it to develop the economic modelling underpinning the NHS Checks programme in 2008 [13]. This demonstrated that QRisk potentially provided better value than Framingham for the £200m annual cost of NHS Health Checks [13]. In 2010, NICE revised their original guidance to support the use of QRisk2 [14]. QRisk technology integrated into the GP electronic record has been an essential component of implementation and instrumental to widespread adoption.

4d: Informing methodological work on risk scores

QRisk development has contributed to the discussion on validation and statistical comparison of models to predict risk, and to debates on multiple imputation. For example, QRisk was a case study in a workshop convened by the Foundation for Genomics and Population Health, Cambridge [15,16]. The debate around the use of routine GP data for predictive purposes has highlighted the potential of large primary care datasets for research purposes (eHealth records research capacity and capability MRC 2011). The open source QRisk calculator has been downloaded from the QRisk website by over 500 separate organisations in the last year and has been used by a number of UK universities (including SCHARR for the health economic modelling for NICE), Cambridge and Imperial. QRISK® is a registered trademark and IP is protected by GNU licences. QRisk has had an international impact – for example, an American paper on health economic assessment used QRisk in an Austrian population [17] and an American review highlighted the importance of socio-economic data in predicting individual and population CVD risk [18].

4e: Promoting development of further risk prediction scores

The principles behind the development of QRisk – using readily available data items on GP systems to calculate real-time risk scores to inform treatment decisions with patients and public health planning – have been applied to other chronic conditions. These include diabetes risk scores (with Dr Robson QDiabetes 2011 www.qdscore.org) and cancer, osteoporotic fracture, renal disease and thrombosis risk tools (Hippisely-Cox J www.QCancer.org).

Prizes, awards and grants

In 2011, Dr Robson received a NICE Shared Learning Award for his work implementing NICE guidance on cardiovascular disease and the John Perry Award of the British Computer Society for his work on this topic. In 2011, he was awarded a two-year NIHR grant to evaluate the NHS Health Checks programme, which will study the extent to which QRisk has been implemented. The team is an important component of CHAPTER – the successful £5m MRC eHealth bid (PI Harry Hemmingway UCL) as the primary care 'arm' of this bid. The team are working to develop data linkage and to demonstrate the success of a new paradigm in improvement science – using networks of local practices that have produced a step change in process and outcomes.

5. Sources to corroborate the impact

9. Spiegelhalter D. *JBS-3: The Joint British Societies' revised guidelines for the prevention of cardiovascular disease*. Lecture given on 8th March 2013 at Royal Society of Medicine, in which he announced that JBS will adopt QRisk in its new joint guideline. www.rsm.ac.uk/academ/lic02.php.

10. van Staa TP. The efficiency of cardiovascular risk assessment: Do the right patients get statins? *Heart* 2013; 0: 1-6. doi: 10.1136/heartjnl-2013-303698.

11. Department of Health. Putting prevention first: Vascular checks: risk assessment and management. 'Next steps' guidance for Primary Care Trusts. London: 2008.

12. Department of Health. NHS Health Check: Vascular Risk Assessment and Management Best Practice Guidance. London, Stationery Office, 2009.

13. Department of Health. Vascular Checks Programme. Economic modelling for vascular checks. London, Stationery Office, 2008.

14. NICE. Change to lipid modification guidance CG67 2010: Available from: www.nice.org.uk/newsroom/news/ChangeToLipidModificationGuidelineCG67.jsp.

15. Dent TH. Predicting the risk of coronary heart disease. The use of conventional risk markers. *Atherosclerosis* 2010; 213: 345-51.

16. Wright C, Dent TH. Quality standards in risk prediction. Cambridge: PHG Foundation for genmomics and population health. *ISBN 978-1-907198-05-2* 2010.

17. Richter A, Thieda P, Thaler K, Gartlehner G. The impact of inclusion criteria in health economic assessments. *Applied Health Economics and Health Policy* 2011; 9: 139-48.

18. Franks P, Tancredi DJ, Winters P, Fiscella K. Including socioeconomic status in coronary heart disease risk estimation. *Annals of Family Medicine* 2010; 8: 447-53.