

Institution: University of Sheffield		
Unit of Assessment: A-02 Public Health, Health Services and Primary Care		
Title of case study: Reducing hospital admissions for suspected heart attack		
Period when the underpinning research was undertaken: 2010–2013		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Steve Goodacre	Professor in Emergency Care	2002–present
Praveen Thokala	Senior Research Fellow	2010–present
Period when the claimed impact occurred: 2014–2020		
Is this case study continued from a case study submitted in 2014? N		
<p>1. Summary of the impact (indicative maximum 100 words)</p> <p>Acute myocardial infarction (heart attack) is diagnosed using a troponin blood test. Our research showed that using a high-sensitivity troponin assay for heart attack diagnosis is more cost-effective than using a conventional assay. It was pivotal in changing National Institute for Health and Care Excellence (NICE) guidelines from recommending conventional troponin testing at 10–12 hours after symptom onset to recommending high-sensitivity testing within 3 hours. This guidance has been implemented across the NHS through the Accelerated Access Collaborative and adopted by 92 of 125 English acute hospital trusts. It has reduced unnecessary hospital bed days and reduced health service costs.</p>		
<p>2. Underpinning research (indicative maximum 500 words)</p> <p>The principal underpinning research was an evidence synthesis and cost-effectiveness modelling of diagnostic strategies for suspected acute coronary syndrome (ACS), funded by the National Institute for Health Research (NIHR) Health Technology Assessment (HTA) Programme. It was undertaken between October 2010 and January 2013 at the University of Sheffield. Professor Steve Goodacre was Chief Investigator and Dr Praveen Thokala undertook the cost-effectiveness modelling.</p> <p>Acute myocardial infarction (heart attack) is diagnosed by blood testing with a troponin assay. Before our research, conventional troponin assays were used. These have poor early sensitivity and do not achieve optimal sensitivity to detect a heart attack until 10–12 hours after symptom onset, so patients with suspected heart attack typically were admitted to hospital. High sensitivity troponin assays detect very low troponin levels and offer the potential for earlier diagnosis of a heart attack, avoiding the need for hospital admission. However, even high sensitivity troponin does not have perfect early sensitivity, so it would inevitably miss a few cases of heart attack compared to later diagnosis with hospital admission. Cost-effectiveness analysis was therefore needed to determine whether the cost savings from reduced hospital admissions justified the increased risk of heart attacks being missed with early diagnosis.</p> <p>Our research used systematic review and meta-analysis to estimate the diagnostic accuracy of high sensitivity troponin assays for heart attack and prognostic accuracy for subsequent adverse</p>		

events. We showed that a high sensitivity troponin assay could identify around 95% of heart attacks within a few hours of hospital attendance [R1].

We then developed a decision-analytic model to estimate, for a hypothetical cohort of people with a suspected heart attack, the cost-effectiveness of early diagnosis using a high sensitivity troponin assay compared to hospital admission and delayed diagnosis using a conventional troponin assay. This showed that early diagnosis using high sensitivity troponin testing was cost-effective compared to hospital admission and delayed conventional troponin testing in all but one of the scenarios examined [R2].

Dr Thokala then collaborated with the National Institute for Health and Care Excellence (NICE) Diagnostic Advisory Committee to produce the economic evaluation of high sensitivity troponin in the 2014 NICE Diagnostic Guidance (DG15). This evaluation developed our model to address the needs of the committee [R3] and confirmed that early diagnosis with high sensitivity is cost-effective according to recognised NICE thresholds.

We also made a substantial contribution to the primary research into high sensitivity troponins that preceded our evidence synthesis. The RATPAC Contemporary Biomarker Evaluation (RATPAC CBE) was an NIHR HTA-funded collaboration between Professor Goodacre and Professor Paul Collinson, from St George's Hospital. Blood samples taken from 850 patients during the Randomised Assessment of Treatment using Panel Assay of Cardiac markers (RATPAC) trial (Chief Investigator Professor Goodacre) were analysed by Professor Collinson, showing that measurement of high sensitivity cardiac troponin was the best single marker for heart attack in patients presenting with chest pain [R4]. These data have since made an important contribution to collaborative meta-analyses definitively determining the early diagnostic accuracy of high sensitivity troponin [R5, R6].

3. References to the research (indicative maximum of six references)

University of Sheffield researchers in **bold**.

- R1.** Goodacre, S., Thokala, P., Carroll, C., Stevens, J. W., Leaviss, J., Al Khalaf, M., Collinson, P., Morris, F., Evans, P., & Wang, J. (2013). Systematic review, meta-analysis and economic modelling of diagnostic strategies for suspected acute coronary syndrome. *Health Technology Assessment*, 17, <https://doi.org/10.3310/hta17010>
- R2.** Thokala, P., Goodacre, S. W., Collinson, P. O., Stevens, J. W., Mills, N. L., Newby, D. E., Morris, F., Kendall, J., & Stevenson, M. D. (2012). Cost-effectiveness of presentation versus delayed troponin testing for acute myocardial infarction. *Heart*, 98(20), 1498–1503. <https://doi.org/10.1136/heartjnl-2012-302188>
- R3.** Westwood, M., van Asselt, T., Ramaekers, B., Whiting, P., Thokala, P., Joore, M., Armstrong, N., Ross, J., Severens, J., & Kleijnen, J. (2015). High-sensitivity troponin assays for the early rule-out or diagnosis of acute myocardial infarction in people with acute chest pain: a systematic review and cost-effectiveness analysis. *Health Technology Assessment*, 19(44), 1–234. <https://doi.org/10.3310/hta19440>
- R4.** Collinson, P. O., Gaze, D. C., Thokala, P., & Goodacre, S. (2013). Randomised Assessment of Treatment using Panel Assay of Cardiac markers – Contemporary Biomarker Evaluation (RATPAC CBE). *Health Technology Assessment*, 17(15). <https://doi.org/10.3310/hta17150>

Impact case study (REF3)

- R5.** Pickering, J. W., Than, M. P., Cullen, L., Aldous, S., ter Avest, E., Body, R., Carlton, E. W., Collinson, P., Dupuy, A. M., Ekelund, U., Eggers, K. M., Florkowski, C. M., Freund, Y., George, P., **Goodacre, S.**, Greenslade, J. H., Jaffe, A. S., Lord, S. J., Mokhtari, A., ... Young, J. (2017). Rapid Rule-out of Acute Myocardial Infarction With a Single High-Sensitivity Cardiac Troponin T Measurement Below the Limit of Detection. *Annals of Internal Medicine*, 166(10), 715. <https://doi.org/10.7326/m16-2562>
- R6.** Lipinski, M. J., Baker, N. C., Escárcega, R. O., Torguson, R., Chen, F., Aldous, S. J., Christ, M., Collinson, P. O., **Goodacre, S. W.**, Mair, J., Inoue, K., Lotze, U., Sebbane, M., Cristol, J.-P., Freund, Y., Chenevier-Gobeaux, C., Meune, C., Eggers, K. M., Pracoń, R. ł., ... Waksman, R. (2015). Comparison of conventional and high-sensitivity troponin in patients with chest pain: A collaborative meta-analysis. *American Heart Journal*, 169(1), 6–16.e6. <https://doi.org/10.1016/j.ahj.2014.10.007>

Grants

NIHR HTA - 09/22/21 Cost-effectiveness of diagnostic strategies for suspected acute coronary syndrome (ACS) £173,447.22 PI Professor Steve Goodacre.

NIHR HTA - 09/22/16 (2010) RATPAC-CBE Randomised Assessment of Treatment using Panel Assay of Cardiac Markers - Contemporary Biomarker Evaluation £158,261.00 PI Dr Paul Collinson Co-I Mr Mike Bradburn, Professor Steve Goodacre.

4. Details of the impact (indicative maximum 750 words)

Our research led to NICE chest pain guidance changing from recommending delayed troponin testing, requiring hospital admission, to early high sensitivity troponin testing, allowing discharge from the emergency department. Admissions with chest pain across the NHS have stopped rising and bed days are falling.

NICE chest pain guidance (CG95) issued (March 2010) before our research, recommended that patients with chest pain suggesting a possible heart attack should undergo troponin testing 10-12 hours after their symptoms. Since people typically attend hospital 2-3 hours after their symptoms this meant that most people with suspected heart attack were admitted to hospital. This guidance reflected increasingly cautious management of chest pain, resulting in hospital admissions with chest pain in England rising from around 130,991 in 1998-99 to 271,118 in 2013-14 (Hospital Episodes Statistics).

Diagnostic cohort studies, including RATPAC CBE, demonstrated the higher sensitivity of high sensitivity troponin assays but cost-effectiveness analysis was required before NICE guidance could change to recommend ruling out a heart attack without hospital admission on the basis of using a high sensitivity assay. This is because the increased risk associated with early discharge, compared to hospital admission, needs to be justified by the cost savings. Our research was the first to undertake such analysis and, by demonstrating the cost-effectiveness of early testing, was pivotal in driving implementation of early testing with high sensitivity troponins.

Professor Goodacre and Dr Thokala were invited to join the NICE Diagnostic Assessment Committee evaluating the potential role of high sensitivity troponin in early diagnosis of heart attack. Dr Thokala collaborated with economic modellers commissioned by the committee, who

used our model as the basis of their analysis that confirmed the cost-effectiveness of early diagnosis with high sensitivity troponin.

In 2014 NICE issued new guidance (DG15) based on our research that recommended using high sensitivity troponin assays to rule out a heart attack within 3 hours of hospital attendance [S1]. This guidance was then incorporated into updated NICE chest pain guidance in 2016 [S2]. NICE anticipated that this guidance would allow a heart attack to be ruled out without the need for hospital admission, thus reducing avoidable admissions and saving NHS costs.

In 2017 the Accelerated Access Collaborative was established to help NHS organisations integrate technologies into everyday practices. High sensitivity troponin to rule out heart attacks was one of three high-potential technology areas with full evidence base selected for implementation in phase one. This involved the NICE adoption and impact team developing a range of tools and resources to drive uptake [S3].

In 2019 we surveyed 131 English acute NHS hospitals [S4], with 110/125 responders (88%) reporting use of a high sensitivity troponin assay, 92/110 (84%) using it for rapid rule-out of a heart attack. Some 69 hospitals provided copies of local guidelines that specified rapid testing for a heart attack using high sensitivity troponin.

Hospital Episodes Statistics show that hospital admissions with chest pain have stopped rising (274,484 in 2019-20) and bed days have fallen from 234,778 in 2013-14 to 144,656 in 2019-20 [S5]. This provides benefit to patients with chest pain by avoiding unnecessary hospital admission, hospitals by reducing pressure on acute beds and the NHS, though cost savings.

A report from the British In Vitro Diagnostics Association (BIVDA) and Innovate UK identified high sensitivity troponin as one of three in vitro diagnostics that between them could save the NHS at least £6.9 billion [S6].

NICE Diagnostic Guideline 40 [S7] has recently superseded NICE Diagnostic Guideline 15 [S1]. [An updated economic analysis](#) commissioned on behalf of NICE reconfirmed that early rule-out strategies using high sensitivity troponin are cost-effective compared with standard troponin testing at zero and 12 hours. The recommendation to use high sensitivity troponin for early rule-out of a heart attack was unchanged. The economic analysis estimated that implementing rapid rule-out with high sensitivity troponin saves between £183 and £210 per patient, compared to conventional testing at zero and 12 hours. Applied to an estimated half million emergency department attendances with suspected heart attacks per year across the NHS, this saves the NHS around £100 million per year.

5. Sources to corroborate the impact (indicative maximum of 10 references)

- S1.** National Institute for Health and Care Excellence. *Diagnostic Guideline [DG15]. Myocardial infarction (acute): Early rule out using high-sensitivity troponin tests (Elecsys Troponin T high-sensitive, ARCHITECT STAT High Sensitive Troponin-I and AccuTnl+3 assays)*. Published date: 01 October 2014. <https://www.nice.org.uk/guidance/dg15>
- S2.** National Institute for Health and Care Excellence. *Clinical Guideline [CG95]: Chest pain of recent onset: assessment and diagnosis*. 2016. <https://www.nice.org.uk/guidance/CG95>
- S3.** National Institute for Health and Care Excellence. Adoption support resource. <https://www.nice.org.uk/guidance/dg15/resources/adoption-support-resource-insights-from-the-nhs-6905227937>

Impact case study (REF3)

- S4.** Thapa, S., Wong, R., & Goodacre, S. (2020). Implementation of rapid rule out of myocardial infarction using high-sensitivity troponin: cross-sectional survey of English hospitals. *Emergency Medicine Journal*, 37(4), 229–231. <https://doi.org/10.1136/emered-2019-209100>
- S5.** NHS Digital, Hospital Admitted Patient Care Activity, Report Tables: Diagnosis <https://digital.nhs.uk/data-and-information/publications/statistical/hospital-admitted-patient-care-activity>
- S6.** British In Vitro Diagnostics Association / Innovate UK. Three simple tests could save the NHS at least £6.9 billion. 2018. http://www.bivda.org.uk/3_simple_tests.pdf
- S7.** National Institute for Health and Care Excellence. Diagnostics guidance [DG40]. High-sensitivity troponin tests for the early rule out of NSTEMI. Published date: 26 August 2020. <https://www.nice.org.uk/guidance/dg40>