Institution: University of Aberdeen

Unit of Assessment: 17 (Business and Management Studies)

Title of case study: Influencing the introduction of self-monitoring coagulometers for NHS patients receiving long-term vitamin K antagonist therapy

Period when the underpinning research was undertaken: 2013-2015

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:
Pawana Sharma	Research Fellow Public Health	08/2008-12/2016
Graham Scotland	Reader Health Economics	09/2001-date
Craig Ramsay	Professor Healthcare Evaluation	01/1995-date
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Period when the claimed impact occurred: 2014-2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

Quality of life for patients on long-term oral anticoagulation therapy is negatively affected by the travel associated with up to 20 regular checks per year at their GP or hospital. Research, led by the University of Aberdeen Health Technology Assessment Group, was responsible for NICE guidance recommendations approving a Roche-manufactured device for self-testing by patients in both England and Scotland. The recommendations underpinned NHS Trust guidelines for patients and carers, saved time in NHS primary care settings, improved the quality of life for patients and generated commercial benefits. 17,000 patients in the UK use the device and in one NHS Trust with 500 patients, the number of out-patients attendees has halved, avoiding over 55,000 in-patient appointments in a seven-year period.

2. Underpinning research (indicative maximum 500 words)

Patients with atrial fibrillation, heart valve disease, or other cardiac conditions are at increased risk of the formation of blood clots in the chambers of their heart. These clots can break away and block vessels in the brain (thromboembolism) causing a stroke. Patients with these conditions often require long-term oral anticoagulation therapy to reduce the risk of clots forming. Of these, 47% take Warfarin (a vitamin K antagonist) with the goal of establishing a balance between the bleeding and clotting risks. Treatment with Warfarin requires frequent monitoring to ensure the patient's international normalised ratio (INR) – a standardised unit for measuring the time it takes for blood to clot – is in the appropriate therapeutic range.

Standard practice is for INR to be monitored by healthcare professionals in anticoagulant clinics. An alternative is the use of a personal coagulometer at home, which allows people to perform self-testing (where they carry out the test themselves and the results are managed by healthcare professionals) or self-management (where they carry out the test and alter their dose of anticoagulation therapy using a personalised protocol). Self-testing and self-management are collectively referred to as self-monitoring. Approximately 450,000 of the 1,500,000 patients in England who take Warfarin are clinically suited to adopting a self-monitoring regime [S3]. It has been estimated that if 25% of these patients took up self-monitoring, it would save the NHS approximately GBP62,000,000 per year [S4]. However, the adoption of new technology and practice in the NHS is very slow [S9]. The work presented in this case study provided the evidence needed for official approval of the approach, which has accelerated growth in the use of INR self-monitoring.

The research presented in this case study [1,2; P1] was undertaken by the Health Services Research Unit (HSRU), Health Economics Research Unit (HERU) and Population Health Medical Statistics group at University of Aberdeen combine expertise as an independent academic centre to undertake technology assessment reviews for the National Institute of Health and Care Excellence (NICE) in England.

In 2013, the National Institute for Health Care Excellence (NICE), through the National Institute for Health Research (NIHR) Health Technology Assessment (HTA) programme, commissioned the University of Aberdeen Group to conduct a technology assessment review of self-monitoring of the coagulation status of people who were receiving long-term vitamin K antagonist therapy, compared with the standard UK practice, where the patient visits their GP or a hospital [P1]. Up to 20 visits per year may be needed [S1].

The study (2015) involved a meta-analysis of randomised controlled trials (RCTs) and assessed the clinical effectiveness of self-monitoring compared to primary or secondary care-based INR monitoring, and created an economic model to assess cost-effectiveness [1,2]. Several personal coagulometers were assessed including the CoaguChek® XS and S models (Roche Diagnostics, Basel, Switzerland). The economic model [2] captured the incidence of stroke and bleeding events in individuals on long-term Warfarin therapy under standard monitoring. Then the effects of self-monitoring were derived from the controlled trials data. The impact of these strategies on the 10-year incidence of stroke and bleeding events was projected. Quality adjusted life years (QALYs) were extrapolated over the 10-year time horizon.

Based on the evidence from 26 RCTs (8,763 participants), both self-management and self-testing were found to be as safe as the standard practice in terms of major bleeding events. Most of the RCTs (22 of 26) related to the CoaguChek® system, and the economic analysis focused on comparing that system with standard INR monitoring. Cost-effectiveness results were also calculated for the other personal coagulometers assuming equivalent efficacy to the CoaguChek® system [2].

The economic model [2; chapter 3] showed mean health and social care costs (per individual) amounted to approx. GBP7,330 for both standard care and with CoaguChek® self-monitoring. Self-monitoring was associated with an absolute reduction of 2.5% in the proportion of people suffering a thromboembolic event and generated an average QALY gain of 0.027 compared with standard care [2]. Applying a cost-effectiveness threshold of GBP20,000 per QALY gained, self-monitoring as whole was found to have 80% probability of being cost-effective compared with standard care. Self-management on its own generated cost savings from the health and social care perspective and generated more QALYs compared to standard monitoring.

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

Systematic review

[1] Sharma, P., Scotland, G., Cruickshank, M., Tassie, E., Fraser,C., Burton, C., Croal, B., Ramsay, C.R. and Brazzelli, M. (2015) 'Is self-monitoring an effective option for people receiving long-term vitamin K antagonist therapy? A systematic review and economic evaluation', *BMJ Open*, 5(6), e007758. DOI: https://doi.org/10.1136/bmjopen-2015-007758

Commissioned report

[2] Sharma, P., Scotland, G., Cruickshank, M., Tassie, E., Fraser, C., Burton, C., Croal, B., Ramsay, C.R. and Brazzelli, M. (2015) 'The clinical effectiveness and cost-effectiveness of point-of-care tests (CoaguChek® system, INRatio2 PT/INR monitor and ProTime Microcoagulation system) for the self-monitoring of the coagulation status of people receiving long-term vitamin K antagonist therapy, compared with standard UK practice: systematic review and economic evaluation', *Health Technology Assessment* Monograph series, 19(48). (Economic modelling in chapter 3), DOI: https://www.nice.org.uk/guidance/dg14/documents/pointofcare-coagulometers-the-coaguchek-xs-system-and-the-inratio2-ptinr-monitor-diagnostics-assessment-report2

Grants:
[P1] **Sharma, P Brazelli, M**. CoaguChek XS point-of-care blood coaguability testing system for those on long-term vitamin K antagonist therapy, NIHR HTA Programme, 13/06/01 (GBP175, 000), this represents the evidence synthesis stage of the research.

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

The research findings described in this case study [1,2] provided the evidence needed for the National Institute for Health and Care Excellence (NICE), to justify the clinical and cost effectiveness for international normalised ratio (INR) self-testing for patients on Warfarin. These findings have underpinned healthcare policy and benefited front-line medical services, patients and commercial companies.

The impacts can be summarised under four headings:
1.Enabling clinical guidelines
2.Reducing the burden on NHS primary care
3.Improving the lives of patients
4.Delivering commercial benefit

Enabling clinical guidelines
Healthcare providers can only use medical devices that are approved. In order for this approval to be granted, the device has to be independently assessed and reviewed by NICE. In 2014 the NICE appraisal committee in England recommended the use of the CoaguChek® XS system, based on evidence in the report it commissioned from the Aberdeen HTA Group [2], [S1i]. The resulting NICE guidance DG14 recommended the system "*for self-monitoring coagulation status in people on long-term vitamin K antagonist therapy who have atrial fibrillation or heart valve disease if: a. the patient prefers this form of testing and b. the patient or their carer is both physically and cognitively able to do the self-monitoring effectively"* [S1i, ii].

NICE diagnostic guidance is provided to help the NHS make efficient, cost-effective and consistent decisions about adopting new diagnostic technology, but NHS clinical commissioning groups (CCGs) do not have a legal obligation to make recommended technologies available. To accelerate the uptake of the recommendations in DG14, NICE produced resources, including a costing statement (updated in 2017), which confirmed the savings associated with its recommendation, to help ensure health service commissioners, health service managers and the public followed the recommendations and that self-care monitoring was adopted across the NHS. The guidance stated, *"Where self-monitoring leads to decreased demand for services such as anti-coagulation clinics there may be savings for both CCGs and NHS England. The annual cost of anti-coagulation monitoring within a primary or secondary care setting has been estimated to be approximately GBP250 per person"* [S3].

The Aberdeen report [2] was also reviewed by the Scottish Health Technologies Group (which provides similar guidance to NICE for NHS Scotland) and used to inform updated advice for NHS Scotland (2015), which said, "*[..], self monitoring of INR, and particularly self-management, where patients carry out both testing and dose adjustment, is likely to be a safe, effective and cost-effective monitoring option for motivated and competent patients receiving long-term vitamin K antagonist oral anticoagulation therapy*" [S2].

Reducing the demand on NHS primary care
The nature of the impact on the health service can best be illustrated by considering the UK self-testing pilot that took place on the Isle of Wight. In 2015–16 the relevant CCG piloted an automated Warfarin self-monitoring service developed by Inhealthcare (a digital health and remote patient monitoring company) with 100 patients using the Roche INR CoaguChek® self-testing device [S5]. The pilot was successful and relieved pressure on GP surgeries and reduced disruption to patient lives. The CCG Primary Care Commissioning Manager stated, *"We hope that this digital service will allow patients to take a greater interest in their condition, monitoring their INR enabling them to stay within their therapeutic range – reducing their risk of a stroke. This reflects NICE's latest guidance on the potential of improving health outcomes with self-monitoring and self-testing"* [S5].

As of 2017, this self-testing digital service has been expanded to patients in Wigan, Bracknell and Ascot, Durham and Darlington and Kent [S5].

The Clinical Lead for the home pilot testing said: *"All warfarin clinics on the island are experiencing a high volume of patients accessing the service, so enabling patients to self-test will alleviate pressure on General Practices. The reduction in patients attending the clinics will allow more time to be spent with more complex patients, increasing the level of care for all"* [S5].

The CoaguChek® Inhealthcare-led system has also been used in the anticoagulation pathway managed by Inhealthcare for the County Durham and Darlington NHS Foundation Trust (CDDFT) since April 2014. It serves 2,500 patients who are taking Warfarin in the region [S6]. A case study stated that from March 2013 to August 2020, the service saved the trust over 55,000 appointments. The Inhealthcare website states, *"In a 24 month follow up, 70 per cent of patients improved their time in therapeutic range by 20 per cent compared to in-clinic monitoring, reducing the risk of stroke by a half"* [S6]. Time in Therapeutic Range increased by an average of 20% for 70% of those on the service and clinicians were able to spend more time with the most complex patients. On a video a nurse commented: *"We used to have clinics where we had 140 patients plus in a three hour period. We were doing our best and we were providing our best but we couldn't provide the patients with that extra bit of care. Now the clinics are down to 70 – 80, and the patients who come through to the clinic are the ones who need our help"* [S6].

Improving the lives of patients

Self-testing is popular with patients. In the Inhealthcare video, the Business Development Manager at County Durham and Darlington NHS Foundation Trust said: *"Sustainability has been strong with 90% of patients who joined the programme three years ago still part of it. The reduction in appointments has lessened the impact on patients' lives"* [S6].

Anticoagulation UK (ACUK) is a small, dynamic charity in the UK that supports patients on warfarin and other anticoagulation therapies and were named stakeholders for the DG14 guidelines. ACUK confirmed that '*NICE DG14 was the stepping stone for individuals to pursue the option of self-monitoring*' but state that further work is needed to accommodate a wider range of people with chronic thrombotic conditions. DG14 guidelines is used as the frame of reference to help direct patients seeking to receive support to self-test [S9i]. Self-testing has been found to empower patients, allowing individuals to manage their condition and take responsibility for their own health [S9].

ACUK are in favour of self-testing, as a result of the freedom that it brings to patients' lives. Their website promotes a video in which Roy, a patient ambassador specifically mentions DG14 and the effect it has had on his life: *"I genuinely do feel in control. I can check my own INR levels when I feel I need to, [..]. Instead of taking time off work, I can just make a phone call and know my dose straight away so I saved my holidays for going on holiday* [instead of going to the hospital]" [S9ii].

Delivering commercial benefit

Roche Diagnostics Ltd have derived commercial benefit as a direct result of the NICE DG14 recommendation to use the CoaguChek® product, which they manufacture. The CoaguChek XS was replaced by the CoaguChek INRange meter, launched in the UK in May 2017 [S1i]. The XS version of the device is still supported by the manufacturer and the testing strips are still available. The CoaguCheck INRange which uses Bluetooth technology, enables patients to wirelessly transmit INR results to their healthcare provider giving them freedom and a sense of empowerment. The instruments are now used by approximately 17,000 self-test patients across the country. The Covid-19 crisis prompted some clinical commissioning groups that were historically less keen on self-testing to encourage its up-take. [*text removed for publication*] [S4].
LumiraDx Care Solutions (INRstar) is the market leader in primary care provision of anticoagulation monitoring services. INRstar, designed by medical professionals has recently been licensed by LumiraDx as clinical decision support software, which enhances the safety and efficiency of point-of-care - anticoagulation clinics, removing the burden on primary and secondary health care settings. INRstar is now used by 11,000 users across 2,700 practices and other

locations in the UK, providing dosing regimens and recommendations for anti-coagulation monitoring directly to patient systems. In order to enable patient self-testing and empower self-care, LumiraDx-enabled INR support is available via the *engage* programme and supporting app, which allows remote testing, ensuring patients dose responsibly whilst communicating their results to their health professional. INRstar has enabled flexibility and freeing up clinical time, which aids both clinicians and patients in making anticoagulation services safer, effective and more cost efficient [S10ii].

The *engage* programme cites DG14 both in its promotional material as justification for using the app and as evidence of the benefits of self-monitoring, thereby increasing customer confidence and aiding the acceptability of it as a service [S10ii]. The Clinical Director of LumiraDx has confirmed that DG14 has acted as one of the reference points throughout the development of INRstar, providing both input on functionality and acting as a cross-reference for suggestions of clinical action, thereby supporting decision-making [S10i]. Since 2018, INRstar service/engage app is now used routinely by East Lancashire Hospital NHS Trust as well as NHS East Lancashire clinical commissioning group and five GP practices. Roche Diagnostics has supplied the handheld devices and training for patients under these programmes to send their INR result to their healthcare professional. Overall, cost savings to healthcare services are predicted at GBP123,612 over five years (2018-2023) compared with usual costs of care for the 200 patients using the service [S10iii]. The *engage* programme has therefore enabled cost savings by developing a model around nurse clinics and healthcare assistants to reduce costs in point-of-care testing.

Patient management during the coronavirus pandemic

NHS England and NHS improvement released clinical guidance for the management of anti-coagulant services during the current pandemic. It stated that 400,000 people had been prescribed Warfarin in the nine months prior to March 2020 [S8] and provided guidance on training patients to self-test INR in their own homes. It cited the NICE guidance stating, *"While a move towards patient self-testing will present challenges in terms of purchasing equipment, [etc., it] should be considered for patients/carers capable of doing this to minimise INR monitoring workload across the system"* [S7].

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

[S1 (group)] (i) NICE recommendation: https://www.nice.org.uk/guidance/dg14 (See "Sources of evidence considered by the committee" tab); (ii) NIHR alert (2015): Self-monitoring of warfarin is safe and cost-effective, NIHR Dissemination Centre: https://bit.ly/3pOJD9y
[S2] NHS Scotland recommendation: https://bit.ly/2P3Gcil
[S3] NICE costing statement: https://bit.ly/3bz0M1K
[S4] Email correspondence with Marketing Manager, Roche Diagnostics
[S5] Inhealthcare Isle of Wight Warfarin pilot: https://bit.ly/37ILA0Z; Inhealthcare case study outlining expansion of pilot in England:
[S6] Inhealthcare website: https://bit.ly/3qS0zNE and video: https://bit.ly/2P8cEAm
[S7] 2020 NHS England clinical guidance: https://bit.ly/3dJmsuE
[S8] 2020 NHS – Clinical guide for the management of anticoagulant services during the coronavirus pandemic (31-03-20): https://bit.ly/3kjRvP7
[S9 (group)] (i) ACUK testimony; patient testimonials; (ii) patient ambassador video (https://www.anticoagulationuk.org/resources; see 'videos' tab ('Roy's story of self-testing his INR') and transcription of video
[S10 (group)] (i) Email correspondence with Clinical Director of LumiraDx; (ii) LumiraDx brochure on warfarin self-monitoring and (iii) NHS *engage* case study (2018)