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# Sustainable approach to reducing unnecessary combined biochemistry tests on a paediatric cardiology ward

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## ABSTRACT

We describe a quality improvement project (QIP) designed to reduce unnecessary biochemistry samples requested on a paediatric cardiology ward in Great Ormond Street Hospital. Prior to the intervention biochemistry tests were requested on a daily basis by nursing and junior doctor staff at an annual cost of around £27 000 for the ward. The lead author observed that for the majority the true indication for these biochemistry tests was for the purpose of monitoring renal function and plasma electrolytes. However, during a diagnostic analysis trying to understand the behaviours around ordering tests it appeared that a broader profile and more expensive combined test set was being requested that included unnecessary liver and bone profile analyses. A driver diagram identified three areas to target in order to rationalise blood test requests: (1) a critical understanding of the purpose of the test by those requesting the tests; (2) effective communication between professionals; and (3) improved utilisation of the computer system. An education-based QIP was initiated with the aim of reducing requests of these costly, unnecessary combined biochemical tests by half, by supporting and encouraging staff to switch to a simpler renal function assay. The project was designed to be engaging and fun and invited clinical teams to consider the cost of wasted resources in terms of the financial implications for the hospital, and in terms of the wider environmental impact of wasted resources illustrated in terms of estimated carbon dioxide use. This perhaps unusual approach of encouraging an awareness of both financial and environmental cost led to a sustained reduction in the ordering of expensive combined biochemical tests, saving an estimated £11 338 (or 13.5%) on biochemistry tests and around 17.8 tonnes of carbon dioxide across a 32-month follow-up period.

## PROBLEM

The key target for intervention was a single wasteful practice identified in the process of requesting biochemistry blood tests on a paediatric cardiology ward. The quality improvement project (QIP) was based on Bear Ward at Great Ormond Street Hospital (GOSH). It focused on the safe and effective rationalisation of blood tests analysed by the ward. The patients on the ward are primarily paediatric cardiac patients; largely postoperative following cardiac surgery or interventions, but also babies and children in heart failure or being monitored between palliative cardiac procedures. The ward, almost always run to full capacity, has eight high-dependency beds and 18 ward beds or cubicles. The regular assessment of postoperative patients and those in heart failure (often receiving multiple medical therapies such as diuretics and ACE inhibitors) necessitates regular testing of renal function and electrolytes in conjunction with clinical assessment of fluid status. However, the lead author observed and then confirmed that when an assessment of renal function was indicated the default blood test ordered was combined biochemical tests, including combinations of renal, bone and liver profiles, other electrolytes and C-reactive protein. The QIP was therefore designed to target this process of requesting biochemistry tests and use education to reduce the practice of ordering unnecessarily complex and more expensive biochemistry assays.

Baseline data were collected in October 2014, reviewing the ordering pattern of biochemical blood tests, daily over 1 week. Of 51 tests ordered, only six translated to simple discreet renal function analysis, test code 'C005' on the computer system, and 45 requests were made using test codes ascribed to a broader biochemical analysis including renal function. Without clear documentation of exact rationales for biochemical testing, a retrospective review of primary conditions, comorbidities, clinical status and medications by the lead investigator found only two neonates with indications for more extensive biochemical analysis (one with jaundice in neonatal period requiring bilirubin screening and the second on high-dose antibiotics with possible liver interaction and no recent liver function testing). Thus, a review of the indication for the biochemical analysis demonstrated that of the 51 biochemical tests requested, only five included a justification for a more extended biochemical profile.

The SMART (Specific, Measurable, Achievable, Relevant and Timely) aim of this QIP was to reduce the number of combined biochemical tests ordered on Bear Ward by half within 8 weeks. We predicted that this would result in an estimated £5000 per annum saving on these biochemical tests. Additionally, using government estimates for carbon dioxide production,[1] the ward staff would be updated on both the estimated financial and carbon dioxide savings. The lead author was supported by running the project parallel to a postgraduate teaching programme on quality improvement led by GOSH (*EQuIP*), allowing sharing of ideas and providing inspiration from other QIPs being run during the same time period.

## BACKGROUND

Wasteful practices in our National Health Service (NHS) occur for a multitude of reasons, from individual behaviour of professionals to wider inefficiencies of systems, and can result in significant negative consequences to the patient, healthcare trusts and the environment. With a background in biological sciences and an interest in sustainable healthcare, the lead author was interested in designing a QIP to reduce waste by highlighting to clinical staff both the local financial implications as well as the environmental impact of our decision-making in healthcare.

In two important articles commissioned for the *Lancet* a multidisciplinary group from the University College of London has described the potential consequences of climate change on global health as the 'biggest public health threat of the 21st century'.[2 3] In this context, systems and outcomes within the NHS should be both measured in terms of their financial, social and environmental costs and benefits. The *Centre for Sustainable Healthcare* has highlighted the benefits of seeking a sustainable healthcare system with successful projects showing waste reduction in the NHS and 'lean healthcare' as a core principle of a future healthcare system fit for the challenges of the 21st century.[4 5] The NHS's own *Sustainable Development Unit* has created a Route Map for our healthcare system in meeting the UK government's ambitious plan to reduce carbon emissions by 80% by the midpoint of this century.[6] One of the key ways we can reduce our carbon footprint is to reduce waste and a report by the Academy of Medical Royal Colleges estimated that the NHS could save £2 billion a year by reducing wasteful practices.[7] Although small in scale, this QIP sought to further demonstrate how simple interventions led by clinicians can help effectively reduce waste in a complex healthcare system. Other similar and successful examples of QIPs include reductions in liver function testing in intensive care at GOSH[8] and reductions in unnecessary echocardiogram imaging requests in the paediatric cardiology specialty.[9]

The implications for patients are more difficult to quantify. Extensive biochemical testing of babies, infants and children without clinical indications could have both unexpected costs and benefits. It is conceivable that liver or metabolic abnormalities, for example, may be found incidentally and in some cases the patient would benefit from early treatment. However, unless a screening process has been planned (adhering to the principles of medical screening[10]), as physicians we should always seek to only test that which is indicated, especially in paediatrics, where blood tests come at a cost to the patient in terms of the pain of the procedure, blood volume in smaller babies and the risk of further investigations for false-positive results.

## MEASUREMENT

Baseline measurements were obtained prior to the QIP: the biochemical laboratory supplied numbers and cost data for all of the biochemical tests ordered on Bear Ward. The C005 renal test was priced at £5 per test compared with the other biochemical tests costing between £7.50 and £15 depending on their complexity. In the 15 months leading up to the QIP, Bear Ward requested an average of £2275 worth of biochemistry tests per month (or £27 300 per year). During the period surrounding the QIP interventions and for the follow-up period, we continued to collect numbers of each blood test requested by Bear Ward.

## DESIGN

Initial interviews of the staff on the ward examined the behaviours and methods by which they ordered daily biochemical tests. Through discussion with the ward clinical team, including the two lead ward consultants, junior medical staff, the ward matron and senior nursing team, the principles behind ordering biochemistry tests were considered and it was agreed that only tests that were clinically indicated should be ordered. The biochemistry laboratory manager was contacted to ensure that with a change in practice a backup option of 'add-on' biochemical tests (after sample collection and processing) could be included, in case the intervention resulted in under-requesting essential blood tests.

A driver diagram identified three primary drivers influencing ordering practice when placing an electronic order for a biochemistry test. These were (1): a critical understanding of purpose for the test by those requesting the tests; (2) effective communication between professionals; and (3) improved utilisation of the computer system. The knowledge of the individuals can be further broken down into three secondary drivers that would influence choice of blood test requests: an understanding of the background of patient and their current clinical status (including medications), common indications for the individual biochemistry tests and a wider understanding of resource use in the NHS.

## STRATEGY

The SMART aim was to reduce the number of combined biochemical tests ordered on Bear Ward by half within 8 weeks. Through a series of PDSA (Plan, Do Study, Act) cycles several sequential and concurrent interventions were introduced over a 3-month period at the start of

2015. The first intervention was in the form of an educational poster (placed throughout the ward in clinical and rest areas) and cartoon-based stickers fixed onto the computer screens showing the C005 logo worn by the ward mascot, a cartoon bear. The poster described our usual patient population and the common indications for biochemistry tests on the ward. It listed examples of where more extensive tests are genuinely indicated and illustrated the issues of resource use within the NHS and the wider environmental implications of wasteful practices. The poster also provided a practical guide to selecting the common C005 test required on the computer system. We postulated that this simple, widely available information will empower staff, especially junior colleagues, in being able to confidently select a narrower biochemical analysis rather than defaulting to a larger test with a perception of safety and covering all bases.

After 3 weeks of displaying the posters and logos, the initial results were communicated to the team with a second poster illustrating the successful reduction in the unnecessary combined tests. Alongside this a target reduction with an incentive of a celebratory tea trolley for staff if the reduction target was met and maintained across the remainder of the 8-week period. After 2 months a progress report was published in the form of a third poster and communicated to the ward team thanking them for a positive engagement with the project, illustrating both the financial and carbon savings achieved to date and encouraging their continued focus on reducing wasteful practices on the ward.

## RESULTS

The following two figures show the results of the QIP across an almost 4-year period of data collection (15 months prior to QIP and 32 months post-QIP). Figure 1 illustrates the sustained threefold increase in the number of C005 tests ordered as a percentage of total biochemistry tests from 13% to 45% and thus a reciprocal significant reduction in the percentage of unnecessary combined biochemistry tests ordered. Interestingly this change in ordering behaviour continues for over 2 years with no further interventions.

Figure 2 shows an initial reduction in the monthly total biochemistry cost for the ward as a consequence of shifting to ordering the cheaper C005 test. In the first year following the intervention, the total monthly biochemistry cost for the ward fell from an average of £2275 to £1742 equating to a saving of £6396 in the first year following the QIP. Additionally, using government estimates converting price to carbon dioxide output,[1] this translates to a crude estimated saving of 10 042 kg (10 tonnes) of carbon dioxide per year which compares with a per capita UK average of 5.9 tonnes in 2015.[11]

From mid-2016 onwards, there was a gradual increase in the total number of blood tests that the ward team was ordering (from approximately 200 tests per week up to 350 tests per week by July 2017) that resulted in a consequential rise in absolute cost. As a proportion, however, the simple C005 test was ordered at a rate three times higher than the baseline prior to the QIP, rising from 13% to 45% averaged across 32 months. If the ordering behaviour for biochemistry tests had continued, then across the 32-month follow-up period, Bear Ward would have spent an estimated £83 681 on their 7521 biochemistry tests ordered. Instead, with the higher proportion of the cheaper C005 test, the observed figure was £72 344, giving an estimated saving of £11 338 or 13.5% on biochemistry tests across these 32 months. Using the calculations above, this would equate to a saving of around 17.8 tonnes of carbon dioxide.

## LESSONS AND LIMITATIONS

This relatively simple and reproducible education-based QIP was designed to raise awareness and incite action on

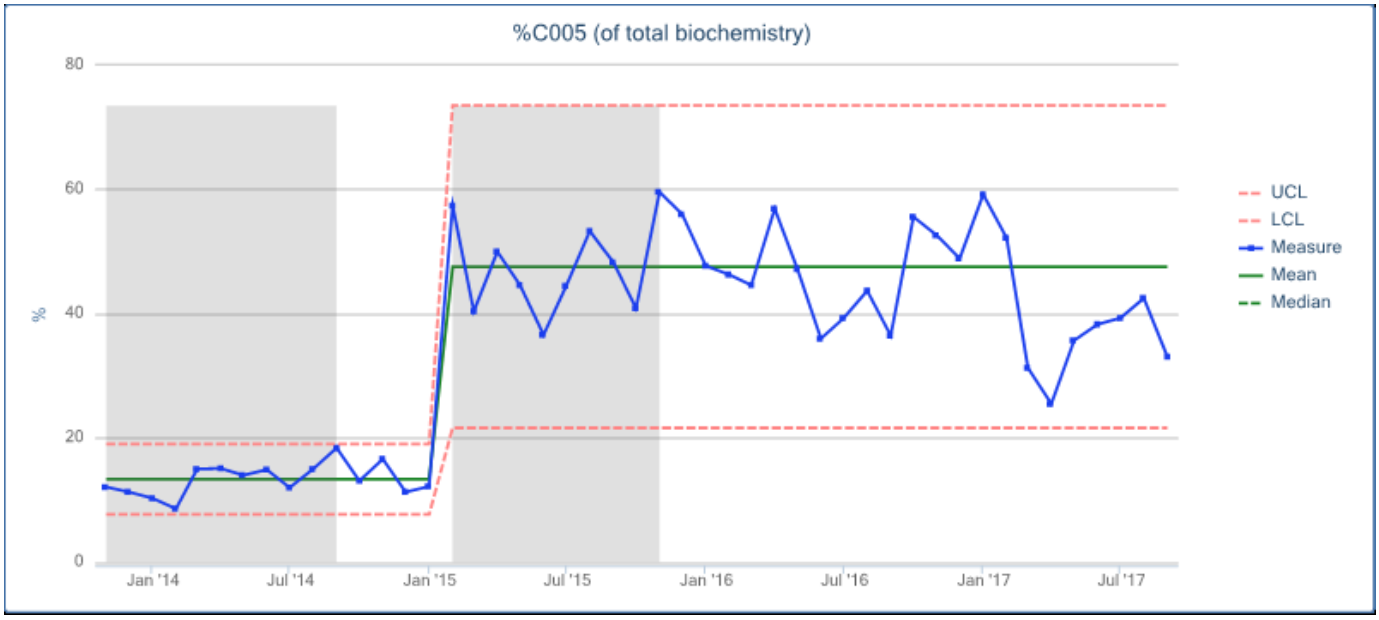


**Figure 1** Percentage of the 'C005' as a total of biochemistry tests ordered. LCL, lower control limit; UCL, upper control limit.

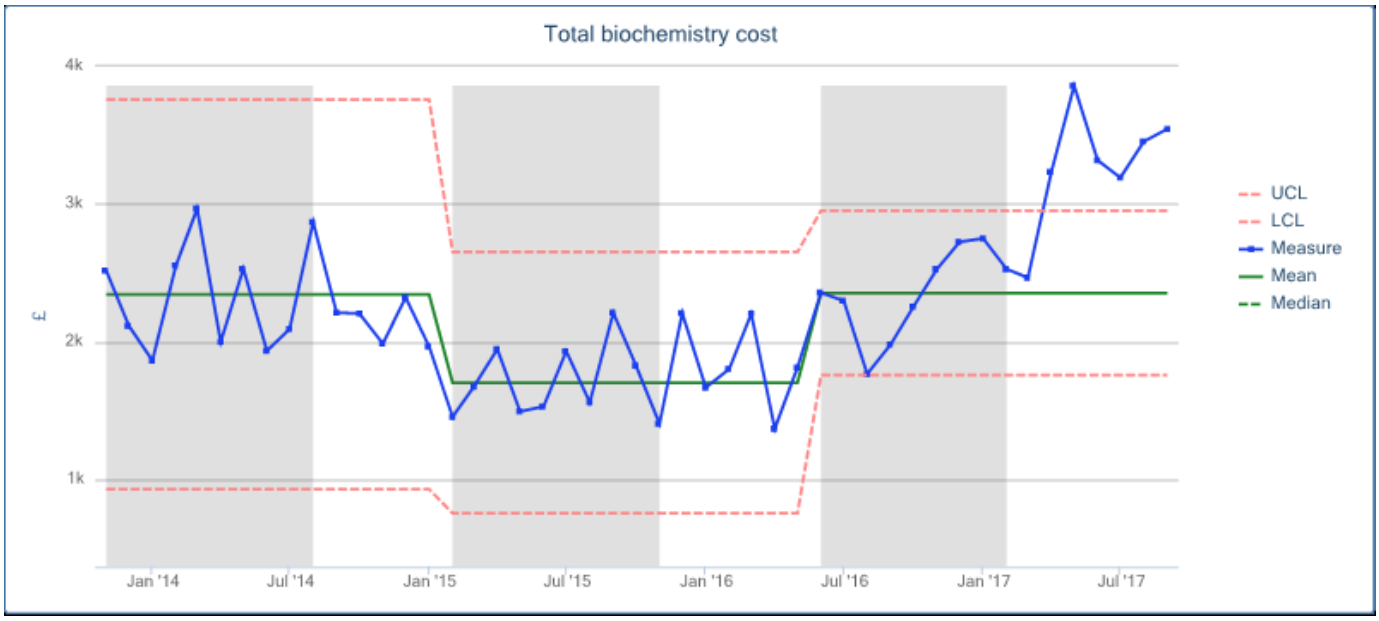


**Figure 2** Total monthly cost of biochemistry (£). Initial reduction following QIP for over 1 year, however, from mid-2016 onwards shows a gradual increase reflective of increased total biochemistry requests. LCL, lower control limit; QIP, quality improvement project; UCL, upper control limit.

wasteful practice within a busy paediatric cardiology ward led by a clinician within the ward team. The project was limited in its size, but effective in producing quick and sustainable improvements. The characteristics, working and behaviours on one ward at a tertiary paediatric hospital may be unique but the simplicity and low cost of the interventions make it a low-risk strategy that could be easily tested to other wards within the hospital, and indeed in other clinical settings in different healthcare trusts.

Our reflection on undertaking the project is that it is key to allow each intervention to be led and co-owned by the relevant clinical teams to gain consensus on what is appropriate for a given cohort of patients without compromising safety or effectiveness. The project was also limited in its data collection with no measurements of bed occupancy or patients' diagnoses, comorbidities or clinical status. Anecdotally, there may have been a change in the average clinical status of the ward patients with more requiring high-dependency care that in part explains what appears to be a sustained upward trend in the total number of ward blood tests ordered from mid-2016 onwards.

## CONCLUSION

The results suggest that this QIP was successful because there was engagement with clinical staff on not only the financial implications of wasteful practices, but the broader environmental implications of wasting resources within the NHS. In the first year, the project achieved its aim with savings exceeding the £5000 per year target. Interestingly, the results showed a sustained improvement in the rationalising of biochemistry tests across a 32-month period of follow-up, despite the planned removal of educational posters and with the usual turnover of nursing and junior doctor staff. These results mirror other QIPs showing successful reductions in wasteful blood test requesting, achieved in part by educating and empowering junior doctors and nursing staff to feel more confident in ordering only those blood tests that are indicated.[8 12] As medical professionals working in a 21st century healthcare system, the lead author would advocate the approach of the NHS's *Sustainable Development Unit* in assessing and improving the sustainability of our healthcare systems, with costs and benefits measured across financial, and social and environmental outcomes.

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