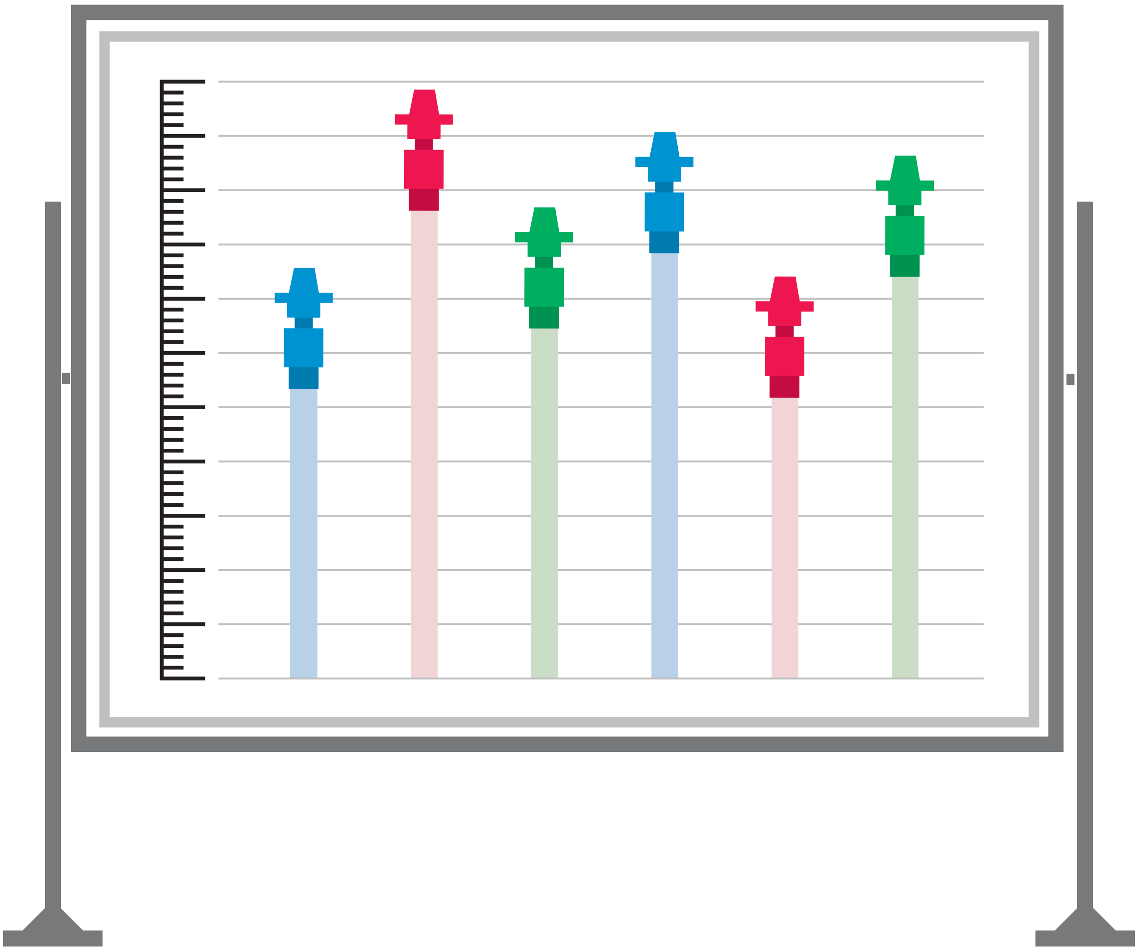
The Health Foundation
Inspiring Improvement

Lining Up: How is harm measured?

Lessons from an ethnographic research study of interventions to reduce central line infections



Learning report

February 2013

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The research was commissioned and funded by the Health Foundation to help identify where and how improvements in healthcare quality can be made.

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This learning report is based upon interviews and the following journal articles.

- Dixon-Woods M, Leslie M, Bion J, Tarrant C (2012). What counts? An ethnographic study of infection data reported to a patient safety program. *Milbank Quarterly* Vol 90 No 3, pp548-591.
- Dixon-Woods M, Bosk CL, Aveling EL, Goeschel CA, Pronovost PJ (2011) Explaining Michigan: developing an ex post theory of a quality improvement program. *Milbank Quarterly* Vol 89 No 2, pp167-205.

More details about the *Lining Up* project are available at www.health.org.uk/liningup

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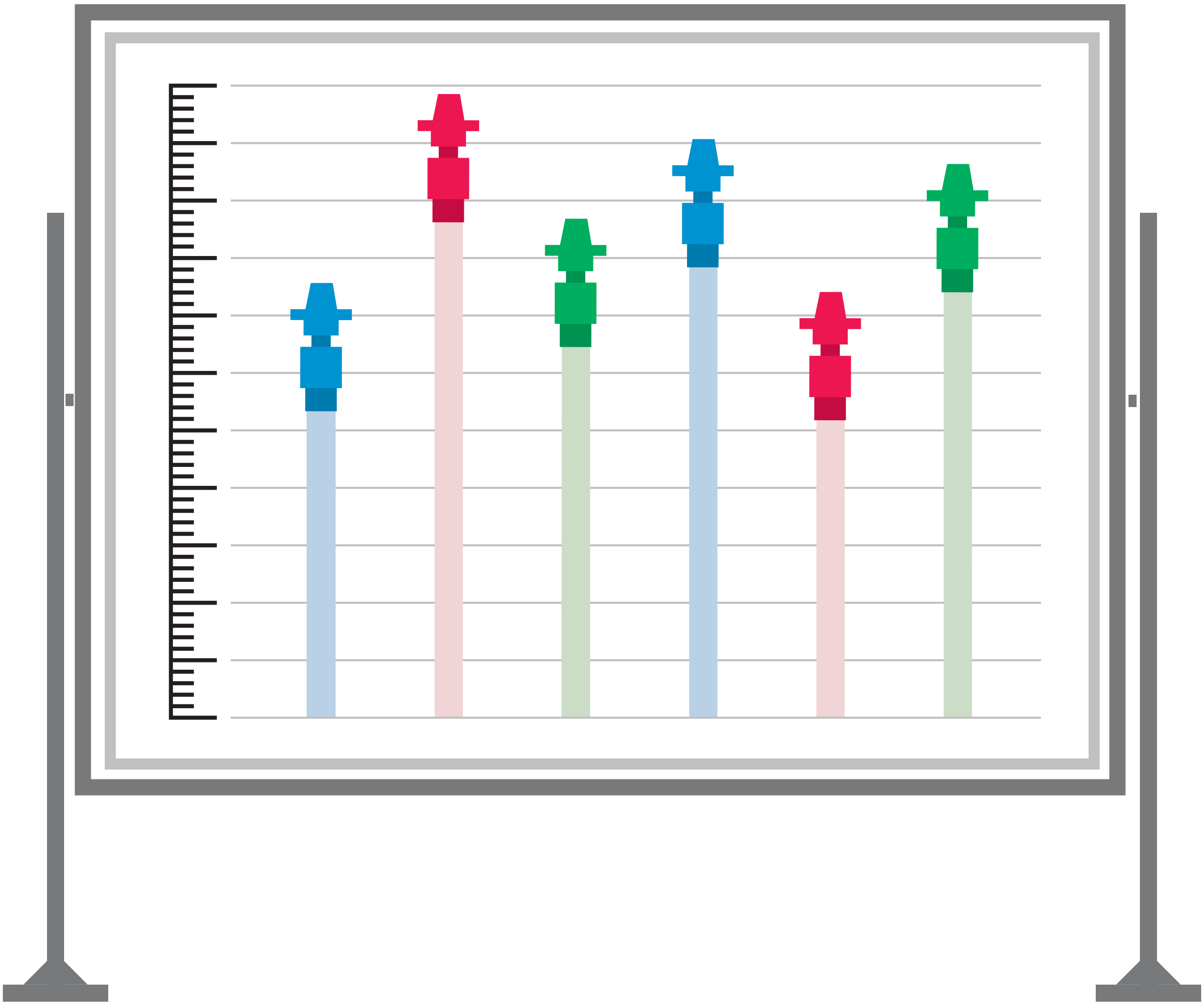


Health Foundation commentary

Measurement is critical to quality improvement. But what do we know about the quality of the measurement and how it can be used?

As the NHS faces unprecedented financial pressures, the need to increase productivity, as well as the clinical imperative to do no harm, has driven a relentless performance measurement culture. There has been an assumption that comparing performance against a benchmark will drive up standards, but little discussion about the challenges of data collection.

This report draws out important lessons about the challenges of measuring infections identified by a large research study, *Lining Up*, that was commissioned by the Health Foundation. The study explored how central line infections are managed and measured in intensive care units in England. Going beyond the measurement data itself, the research team used ethnographic study methods to gain rich understanding of practice by observing what staff actually did, as well as what they said they did.

The study demonstrated that the units collected data on infection rates in very different ways, with the implication that comparison across units is almost meaningless. These differences have been noted in relation to other comparative health data but are commonly attributed to 'gaming', in which staff are thought to deliberately bend the definition to meet the current performance target. But *Lining Up* provides a different explanation.

Measurement in the practice setting was shown to be a social process. The interpretation of the guidance on counting infections was seen to be heavily influenced by the standard working practices of each of the units. Three main points of difference were observed: access to microbiology results; the processes by which data was collected (by whom, when and from which sources); how units interpreted the inclusion/exclusion criteria.

By demonstrating the complexity of measuring healthcare outcomes, *Lining Up* draws attention to the clear distinction between measuring absolute values (as required for research purposes) and measuring trends (as required for improvement purposes). It serves to remind practitioners, managers, commissioners and policy makers to be mindful of the non-technical aspects of measurement.

These findings are likely to apply to a wide range of clinical outcome measures, not just central line infections. Clinical leaders and healthcare managers can learn lessons from this report about the limits of measurement, including the following in particular.

- Understanding local working arrangements is a key consideration when designing comparative measures. For example, large, tertiary centres are more likely to have specialist staff and rapid access to microbiology testing than smaller district general hospitals and therefore benchmarking measures need to be designed to suit a range of unit types.
- Measures should be designed in conjunction with all the staff who might be involved in collecting the data, to ensure that the guidance is unambiguous and is workable for all the participants.

The recent publication of the report of the Public Inquiry into Mid Staffordshire NHS Foundation Trust raised serious questions about the credibility of quality and safety measures and their contribution to assuring healthcare services. The Health Foundation will be working to explore the issues around the complexity of measurement in healthcare. This report contributes to the beginning of that conversation.

Dr Elaine Maxwell
Assistant Director
The Health Foundation

1 Introduction

Summary

This is the first of a series of reports looking at lessons from the Health Foundation's *Lining Up* research project – an investigation into interventions to reduce central line infections. The report describes findings that have important implications for measurement of performance, and using measurement to improve quality and ensure patient safety. It is intended for managers, practitioners, improvement leaders and policy makers.

By observing implementation of a nationally organised infection control programme, the *Lining Up* research team discovered how organisations go about interpreting data definitions, collecting data and reporting results. Apparently straightforward measurement tasks were found to be highly complex and subject to a range of human factors that rendered them so inconsistent as to undermine comparisons between organisations. This implies that policy makers need to be cautious about attaching incentives and penalties to findings reported for performance management purposes. The project also demonstrates that, without a standardised approach and excellent data collection, quality improvement initiatives will fail to change culture or behaviour.

Measuring performance is a fundamental function of modern healthcare, essential to ensuring accountability and monitoring patient safety. Yet little is known about how healthcare organisations undertake the tasks of measurement. There is an urgent need to understand more about how performance measures operate to support patient safety, especially as health systems worldwide move towards linking these measures to payments and sanctions.

The *Lining Up* project aimed to shed light on what happens when organisations are asked to interpret data definitions and collect and report data.

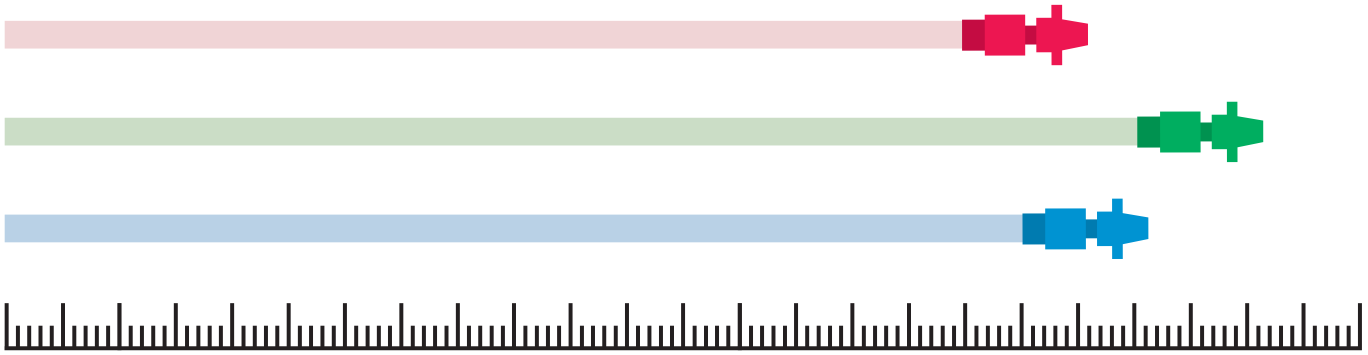
In 2009 the Health Foundation commissioned a team from the Universities of Leicester and Birmingham to investigate efforts to reduce the rate of bloodstream infections (BSIs) linked to central venous catheters (CVCs, often referred to as 'central lines') in intensive care units (ICUs) in England. The research focused particularly – though not exclusively – on *Matching Michigan*, a two-year National Patient Safety Agency (NPSA) programme in England. *Matching Michigan* was based on the highly successful Michigan Keystone project, which reported a dramatic reduction in CVC-BSIs in over 100 ICUs in the US state of Michigan.

Lining Up provided the team with a rare opportunity to study in real time, and at first hand, the processes involved in producing performance data relating to CVC-BSIs. Researchers were able to conduct interviews and observations in a sample of ICUs taking part in the programme, and hold telephone interviews with further ICU staff who attended *Matching Michigan* training events.

Professor Mary Dixon-Woods of Leicester University, who led the research, says: 'Hospitals and other organisations are constantly being told to count and report things. There are very few studies of how they go about it. This is one of the first detailed, close-up observations of what happens when people are asked to count infections'.

For more details, see:

— Dixon-Woods M, Leslie M, Bion J, Tarrant C (2012). What counts? An ethnographic study of infection data reported to a patient safety program. *Milbank Quarterly* Vol 90 No 3, pp548-591.



Context

Why measuring performance matters

Performance measures are an increasingly prominent feature of healthcare systems; the case for setting explicit standards and assessing performance against them is a powerful one. Measuring performance can enhance accountability and transparency, expose practice to critical scrutiny, identify variability in quality of care and create opportunities for remedial action. An organisation that sets goals and monitors performance against them may gain a sense of mission around which it can mobilise and cohere. Giving people goals may motivate better performance; setting a target can signal that an activity is to be a priority; providing feedback may promote learning. The challenge is to design performance standards and targets that will produce the best effect, as people may respond to them in unintended ways.

Infection control as a performance measure

Healthcare-acquired infections (HCAIs) have emerged as a high-visibility, high-consequence performance measure for health systems worldwide. The NHS has devoted much effort to combating HCAIs since the mid-2000s after massive public concern and media clamour: for example, it halved MRSA rates in four years. Trusts have had a legal responsibility for infection control since 2006. The Care Quality Commission holds them to account for this.

Several initiatives to reduce infections have been undertaken. These include the Health Foundation's *Safer Patients Initiative*, which involved 24 hospitals in the UK, and the *Patient Safety First* campaign, which recruited most NHS trusts in England from 2008 onwards. The Department of Health's *Saving Lives* infection control programme began in 2005. All three initiatives included measures aimed at reducing CVC-BSIs (see Box 1).

Why CVC-BSIs?

Box 1: What are CVC-BSIs?

Central venous catheters (CVCs), also known as central lines, are narrow tubes inserted into large veins, with the tip lying close to the heart. They allow vascular access for purposes such as administering drugs and fluids, taking blood samples, measuring venous pressures and providing haemodialysis.

CVCs increase the risk of life-threatening bloodstream infections (BSIs) by enabling bacterial and fungal pathogens to enter the patient's bloodstream directly. Sepsis and other complications may cause serious morbidity, prolonged hospitalisation or death, as well as increased costs.

Research evidence strongly indicates that many CVC-BSIs are avoidable.

CVC-BSIs are now a key focus of interest internationally. The Michigan Keystone project generated worldwide attention when, in 2006, it reported a dramatic reduction in CVC-BSI rates in over 100 ICUs in the US state of Michigan. In the US since then, CVC-BSIs have become a core measure of quality used by accreditation agencies and payers, and are increasingly tied to sanctions. They are deemed a Medicare 'never event', meaning that organisations cannot claim reimbursement for any costs associated with their treatment. From 2013 hospitals must submit data on CVC-BSIs or face a reduction in their Medicare inpatient annual payment update.

In the UK, Lord Darzi's Next Stage review of the NHS in 2008 announced a 'dedicated national patient safety initiative to tackle central line catheter-related bloodstream infections, drawing lessons from a remarkably successful Michigan initiative on the same topic'. *Matching Michigan* began in April 2009.

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The *Lining Up* research project

Rationale

When the Health Foundation commissioned a team from the Universities of Leicester and Birmingham to carry out the *Lining Up* project in 2009, multiple efforts to control CVC-BSIs were underway in England and a dedicated national programme, *Matching Michigan* (see Box 2), was being introduced. This presented a rare opportunity to study the implementation of – and response to – a major patient safety initiative as it happened.

The *Lining Up* research team was particularly keen to examine how healthcare organisations go about setting up data collection systems, how they collect data, and how they interpret data definitions in order to report their performance. Studies of how numbers are produced specifically for performance measures are rare, particularly in healthcare.

Emerging evidence from the US indicated significant variability in how definitions of these rates are interpreted and applied. For example, US research has found substantial inconsistency in reported CVC-BSI rates in ICUs following widely used definitions devised by the US Center for Disease Control and Prevention (see Box 3). One study of 30 ICUs over 30 days estimated that 52% of infections meeting the CVC-BSI criteria had not been reported, but also identified some over-reporting. It concluded that overall infection rates were 78% higher than reported.

Methods

The *Lining Up* project used ethnographic techniques to observe the culture and behaviour of the ICUs included in the research. This enabled insights into the day-to-day practices involved in collecting and reporting data that may not have been possible to gain using other methods.

Seventeen adult ICUs across England that were *Matching Michigan* participants, as well as two ICUs that did not to take part in the programme, were chosen for inclusion in *Lining Up*. Researchers spent 910 hours in the 19 ICUs, averaging 48 hours per ICU. They undertook observations of care on the units, including CVC insertion.

Researchers also conducted face-to-face interviews with 98 ICU nurses, doctors of varying grades and, where possible, with microbiology staff. They carried out 29 further telephone interviews with staff who had attended *Matching Michigan* training events, including senior managers and executives. The *Lining Up* team attended all training events and a selection of *Matching Michigan's* team and external reference group meetings.

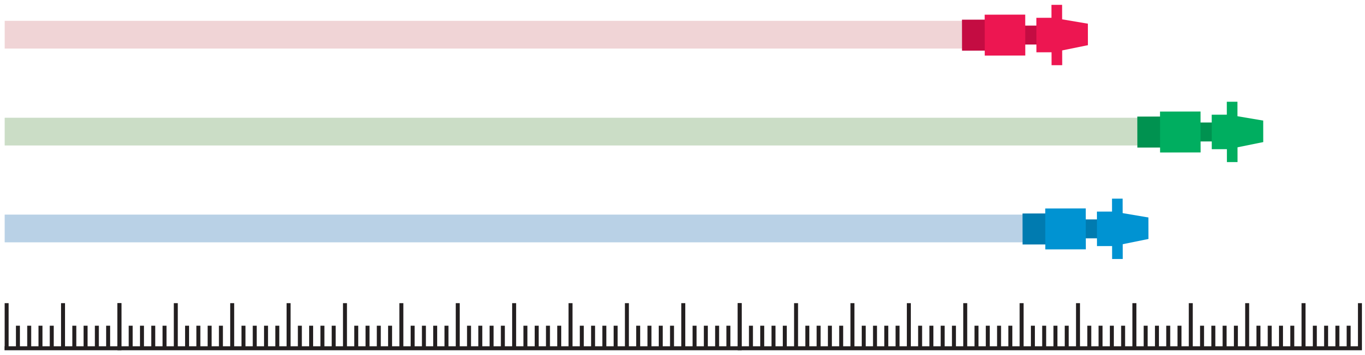
Further details

The *Lining Up* research team have published a number of journal articles, including:

— Dixon-Woods M, Leslie M, Bion J, Tarrant C (2012). What counts? An ethnographic study of infection data reported to a patient safety program. *Milbank Quarterly* Vol 90 No 3, pp548-591.

— Dixon-Woods M, Bosk CL, Aveling EL, Goeschel CA, Pronovost PJ (2011) Explaining Michigan: developing an ex post theory of a quality improvement program. *Milbank Quarterly* Vol 89 No 2, pp167-205.

For more details about the project, visit: www.health.org.uk/liningup



Box 2: *Matching Michigan*

Matching Michigan aimed to equal or better the Michigan Keystone project's reduction in infection rates by:

— standardising definitions and ways of measuring CVC-BSIs

— creating an online data collection and reporting system for CVC-BSIs in ICUs in England

— minimising CVC-BSIs in ICUs by supporting best practice

— promoting technical and behavioural interventions to enhance patient safety.

It was envisaged that producing evidence of CVC-BSI rates would reveal to ICUs how well they were doing and, where necessary, provoke action to improve. Modifying culture and behaviour would, it was hoped, promote adherence to the technical interventions and have an impact on patient safety generally.

Each participating trust had to form a *Matching Michigan* safety team and attend two training events. They also had to return monthly data on infection and exposure rates to the data collection system, and complete surveys on infection control and safety culture. The NPSA invited all 223 ICUs in NHS acute hospital trusts in England and, even though participation was not compulsory, recruited 215, of which 196 were adult ICUs. The programme was rolled out in four clusters beginning in May 2009. It concluded in April 2011.

Although it was modelled on the Keystone project, *Matching Michigan* was not an exact replica: the interventions were mostly the same, but differed in some details. The technical interventions used in the programme had already been established as good practice in the form of the Department of Health's High Impact Intervention on CVC care. However, it was unclear how well or consistently the interventions were implemented at the time the programme was introduced. The programme's non-technical interventions (targeting culture and behaviour) were modified somewhat from the Keystone project, but were broadly similar.

Matching Michigan was introduced in a very different context to the Keystone project: in Keystone, there had been no previous large-scale initiatives and infection rates were twice as high at the beginning of the project as they were in England at the outset of *Matching Michigan*.

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The findings

Matching Michigan sought to provide clear and explicit definitions of how to measure infection rates, and was the first programme to require units to distinguish between two different methods for diagnosing central line infections (see Box 3). However, *Lining Up* showed that ICUs varied in how they interpreted the definitions. The decisions made by the ICUs about what to measure, and how to measure it, varied to such an extent that comparisons between them were of doubtful validity.

Differences in approaches to measuring infection rates were not, as is sometimes suggested, due to staff 'gaming' the system. Instead, they arose because counting, measurement and data collection are not straightforward technical processes, but social ones too – people do the measuring rather than machines, and so the measurements are affected by a range of subjective human factors.

Calculating and collecting infection rate data

Monitoring and feeding back data to the ICUs had been perceived as vital to the success of the Keystone project, and it was intended to play a similar role in *Matching Michigan*. Information on infection rates would, it was anticipated, spur action where problems existed.

The *Matching Michigan* programme required ICUs to:

— count all patients with CVCs, and how many each patient had, at the same time every day

— collect data on infections that were eligible for reporting to the programme

— compile microbiology test results linked locally to patients' records and decide which infections satisfied the programme's definitions

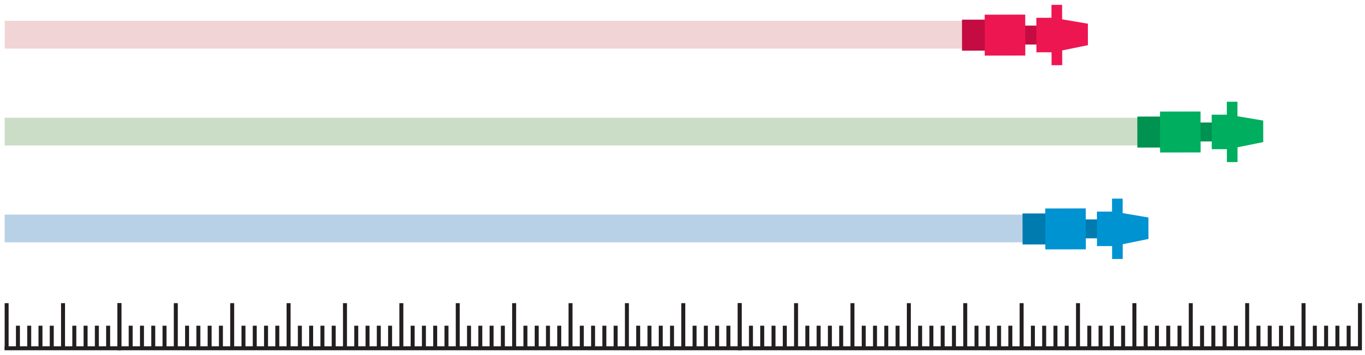
— submit infection data two weeks after the month's end.

However, these tasks proved far from straightforward. Two problems became apparent.

— To accommodate local variability in resources for data collection and microbiological laboratory techniques, no single method of data collection was prescribed. This resulted in units setting up different systems for collecting their data.

— The international definitions used by the project distinguished between two levels of evidence for diagnosing CVC-BSIs. The more commonly used definition (catheter-associated BSI – see Box 3) required staff to exercise clinical judgement in deciding whether or not an infection was attributable to a central line, resulting in varied local interpretations of what should be reported.

Both issues led to variability among the ICUs in the quality of data collected. In some units the data lacked local credibility, removing its power to convince. This in turn affected the extent to which it could help bring about changes in culture and behaviour. It also undermined the comparability of data across ICUs.



Box 3: Calculating infection rates

CVC-BSI rates are conventionally reported as the number of BSIs per 1,000 CVC patient days, on a monthly basis. To calculate this rate an ICU must have clear definitions of what counts as a 'CVC patient day' and what constitutes a BSI. However, such definitions can be controversial, and are not always used consistently.

Counting CVCs

As patients may have more than one CVC, should the unit of analysis be the patient or the CVC? US guidance suggests it should be the **number of patients** with one or more CVC – the 'CVC patient day'. But some use the total **number of CVCs** in use – 'total CVC days' or 'device days' – and studies are often vague or inconsistent in specifying which they used.

For *Matching Michigan*, a CVC patient day referred to any 24-hour period in which a patient had one or more CVC for all or part of the day. This definition was the one used to calculate infection rates (although ICUs were also asked to collect data on the total number of CVCs in use – total CVC days). A patient with more than one CVC was therefore counted as one CVC patient day. However, patients with more than one CVC are more susceptible to infection, so patients with different risk profiles were mixed together. This potentially obscured the very varying challenges ICUs faced in controlling infections in different kinds of patient.

Defining BSIs

What counted as a CVC-BSI for the purpose of reporting to the programme was also fraught. Determining whether a CVC is to blame for any bloodstream infection detected in a patient is not a straightforward matter of applying simple technical criteria.

A positive blood culture taken from a CVC or from the tip of a CVC removed from the patient is not enough to conclude definitively that the CVC is the source of the infection: micro-organisms can travel through the bloodstream from a remote site of infection and then be sampled from an uninfected CVC, or they can lodge on and colonise a CVC. Catheter tips can be contaminated when being removed, perhaps by picking up micro-organisms on the skin. The CVC may be only one of several competing suspects to blame for an infection.

Like many other surveillance programmes, *Matching Michigan* used the US Center for Disease Control and Prevention definitions, which distinguish between catheter-**associated** infections and catheter-**related** infections. The difference relates to the standard of proof used to determine whether the CVC is the infection source.

— The **catheter-associated BSI** definition requires only a single blood culture indicating infection in a patient with a CVC, taken either from a peripheral vein, directly through the CVC or from the catheter tip following removal, together with clinical judgment that no other source is responsible for the infection. A doctor might consider, for example, whether a patient's condition improved after CVC removal, which might suggest the CVC was a plausible – though not definite – source of infection. This definition identifies most infections originating in the CVC, but increases the risk that a CVC will be blamed for an infection that actually had its source elsewhere.

— The **catheter-related BSI** definition demands a higher standard of proof, seeking to establish beyond doubt that the CVC is to blame. It requires two blood samples indicating infection, one from the CVC tip or from a sample taken through the CVC and a second peripheral vein. Both must test positive for the same micro-organism, determined using semi-quantitative or quantitative techniques. Many hospital microbiology laboratories are unable to perform semi-quantitative analyses because of complexity and cost.

Differences in systems for collecting data

Only a few ICUs had established systems for counting their CVC-BSIs before *Matching Michigan*. While the programme provided explicit definitions, it did not mandate a common method for data collection. The *Lining Up* team found three types of data collection system operating across the various ICUs (see Box 4). All three featured a 'controller' responsible for submitting their unit's data to the programme's online database. In most ICUs the controller was the *Matching Michigan* clinical lead – usually a senior doctor in the hospital – but sometimes the controller was a senior ICU nurse or a senior infection control nurse.

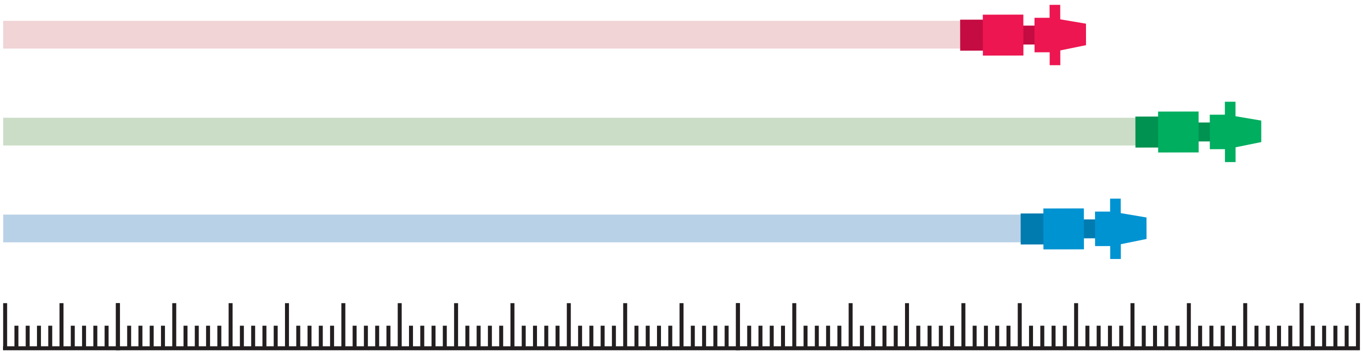
The three systems faced different challenges – some specific to each, others common to all – and they were prone to different types of data loss. From the start, data collection proved an area of intense controversy. Even something that appeared straightforward – counting CVC patient days, CVC days, and CVCs – turned out to be fraught with ambiguity.

The three types of data collection system varied in what they provided to the controller, who needed information on suspected BSIs – with supporting test results and medical records – to decide which infections to report to the programme. The three 'track-trigger-track' units kept BSI data in one place and in a standardised form, so their controllers had ready access to information needed for making decisions. This proved an impetus to learning, and one ICU dramatically reduced infection rates as a result. Most other units experienced multiple difficulties: records of CVC insertion, signs of infection and microbiology results all tended to be patchy and disorganised.

On 'patrol' units, nurses collecting data often had to rifle through electronic records or multiple documents stored in different places. One patrol nurse was observed to miss an infection discussed in an earlier ward round and it went unrecorded. Because patrol nurses were ICU 'outsiders', the data they collected tended to be subject to challenge, with staff denying that high rates reflected clinical realities.

In most 'controller-centred' units, staff were supposed to record suspected CVC-BSIs on a standardised form that the controller would use to decide which infections to report. But staff were routinely seen to initiate treatment for a suspected BSI without completing the form: it was easy to forget when attention was focused on the patient and form-filling seemed a bureaucratic distraction. Controllers varied in their ability to access patients' records, microbiology reports and relevant clinical information, often due to mundane problems of co-ordination and organisation.

As a result of this variability, controllers were not all making decisions about the same things.



Box 4: Systems for collecting data

Track-trigger-track (used by three ICUs)

This system integrated routine monitoring of patients' infection status and treatment with recording of the data required for counting purposes. On a daily basis, a member of staff went round and captured data for each patient, using a CVC data collection form – the initial tracking. They drew on bedside records, direct observations of patients, and discussion with nurses and doctors involved in the patient's care. These staff continually checked and validated CVC data and suspicions about infection. Staff caring for the patient were provided with multiple prompts – for example, reminding them to send blood samples to the microbiology laboratory for analysis.

The controller reviewed the data collection forms at the end of each month. Any patient flagged as indicating a possible CVC-BSI triggered a full investigation by the *Matching Michigan* lead, who would then track back through the test results, retrieving the patient's clinical charts and consulting clinical colleagues.

Patrol (three ICUs intended to use this; only one collected and submitted data)

This system removed responsibility for counting CVCs and infections from ICU staff. Infection control nurses from outside the ICU visited daily to count CVCs and identified possible CVC-BSIs, using medical and nursing treatment charts and observation of patients, occasionally discussing cases with staff. The patrolling nurses did not generally prompt for samples to be sent for analysis, relying instead on the existing information in clinical records.

At the end of each month, the controller reviewed the data collected by the patrolling nurses and microbiology test results for patients identified from the patrol records as possibly having had a CVC-BSI. The controller then decided which, if any, of the programme's definitions had been satisfied – usually without direct input from clinicians involved in the patient's care.

Controller-centred (used, with some variation, by 11 ICUs)

ICU nurses counted patients with CVCs, although sometimes this task was assigned to a junior doctor. They toured the ICU beds at a particular time of day, counting patients with CVCs using direct observation, review of treatment notes and consultation with nursing staff. Results were transcribed onto a form and given to the controller for the end of the month.

The controller generated infection rates by identifying which patients appeared to have been diagnosed with a CVC-BSI in the previous month. In two ICUs, controllers relied on their own memory, treatment chart analysis, occasional prompts from colleagues and sorting through batches of test results to count CVC-BSIs retrospectively at the month's end. In the other nine, ICU staff identified patients who might have a CVC-BSI, recorded their suspicions or otherwise notified the controller, and ensured microbiology follow-up took place. These notifications prompted controllers to identify possible candidate infections for reporting to the programme, and were usually supplemented with review of records and microbiology reports.

Differences in reporting

The ICUs differed in what they reported to the *Matching Michigan* programme, to such an extent that it threatened the comparability of the data. However, this variability did not arise from staff 'gaming' the system to present their unit's performance in the best light. Rather, it was the result of the data collection systems' logistical challenges, differences in clinical practice, doubts about the legitimacy of counting and counting methods, and a perception that the definitions used by the programme for calculating infection rates were subjective and possibly unfair.

Eligible CVCs

How units counted patients who were eligible for inclusion, according to the programme's criteria, varied. Sometimes patients who were deemed unusual – for example if they had particular kinds of surgery or had been admitted from another hospital – were considered not to qualify. In some cases, these were patients at higher risk of a central line infection, and thus their exclusion might paint a more favourable picture of the infection rate for those units. However, some ICUs also excluded patients at lower risk of infection, because they felt that including them would give a misleading and overly flattering infection rate. Both approaches were honest attempts to provide meaningful information.

Counting of CVCs did not always happen reliably or at the same time each day. Sometimes it was done by harvesting data from forms already completed for other purposes, but this was not always a reliable method. Sometimes catheters were invisible under blankets, or patients undergoing a procedure could not be observed; some were moved to another ward before being counted.

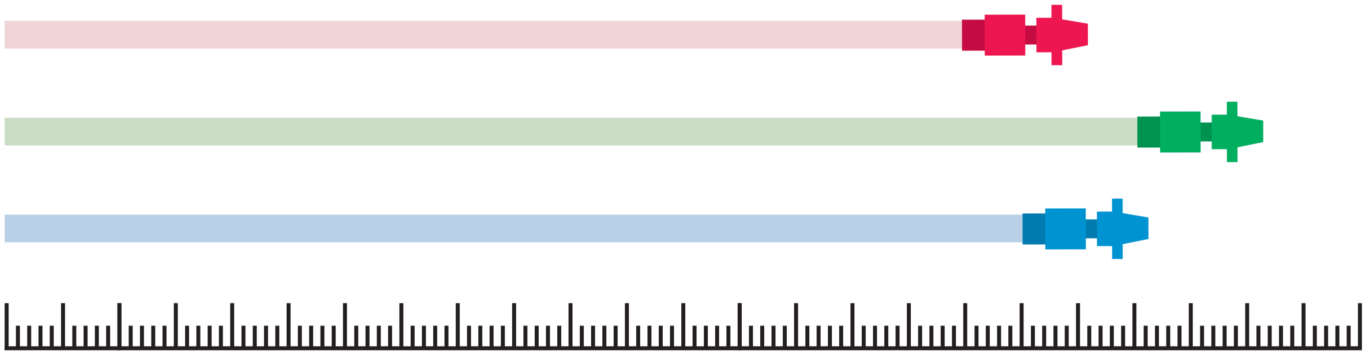
Eligible infections

Researchers found considerable variability in what ICUs counted as a CVC-BSI for purposes of reporting to the programme. Those using the catheter-related definition had to meet a high standard of evidence, so might report few infections; those observing the lesser standard of evidence of the catheter-associated definition could end up reporting more infections.

Most ICUs used the catheter-associated definition of a BSI, which relies heavily on clinical judgement. Most clinicians saw this definition as slippery and subjective. Some doctors felt confident attributing an infection to a CVC, but many were uncomfortable and uncertain. Some controllers were quick to blame the CVC, even with relatively little evidence; others favoured finding any reasonable explanation other than the CVC. Some involved colleagues in their decisions, others acted alone. Some ICUs deferred to microbiological expertise to make the judgement, but microbiologists often felt the same ambiguity about whether a CVC was to blame for an infection. These factors led to considerable variability in what was counted as a CVC-BSI.

Local clinical practice

Matching Michigan's quest for a precise and definitive judgement on whether a CVC had caused an infection was difficult to reconcile with the way clinicians routinely managed patients. Faced with a patient who might have a BSI, doctors were often uncertain about whether the CVC was the source and – needing to act quickly – could not always wait for microbiology results. Patients might improve in response to subsequent therapy and be discussed during ward rounds as having likely CVC infections, but without a blood sample



analysis they would not be reported to the programme. Infections could therefore be treated as CVC-BSIs for clinical purposes while not being counted as such for audit purposes.

ICUs varied in what they sent to their microbiology lab for analysis. Some specified all CVC tips, potentially yielding many more possible infections than those that sent only occasional tips. But confusion or lapses often occurred. Some nurses thought all tips were to be submitted, others only suspicious ones – although they were unclear about the criteria for establishing suspicion. Doctors varied in their preferences. Even when doctors asked during ward rounds for cultures or tips to be sent for analysis, losses often occurred: nurses who were not well briefed sometimes discarded tips marked for lab analysis. Samples went missing because of the logistical difficulties of arranging for them to be taken, labelled and dispatched to microbiology. Losses of data necessary to decide whether a CVC was the source of an infection were therefore common, and linked to the realities of caring for patients in busy, stressful environments.

Microbiology departments varied in the analyses they undertook and in their definitions of whether an infection was CVC-attributable. Most labs were unable to produce the analysis for defining a catheter-related BSI. This was also not seen as a priority as patients could be treated without it. Some modified their work routines to accommodate *Matching Michigan*; most did not. Some microbiologists merely advised on test results and correct antibiotics, having little contact with ICU clinical teams. Others were full members of ward rounds, and some were active in prompting ICU staff that a patient might qualify for inclusion in the programme, alerting controllers accordingly.

Local culture and individual clinician preferences appeared to give rise to this variability, rather than attempts to conceal possible infections.

Attitudes to performance management

For units that regarded the programme as an externally imposed audit of little relevance to clinical care, the data was a source of fear rather than learning, or a tedious distraction from the real work of caring for patients.

Where data lacked local credibility, little change occurred. If it indicated infection rates were low, it had the potential to reassure – possibly inappropriately – that no action was needed. Data indicating high rates were, on the other hand, prone to being dismissed by senior clinicians as poor quality and lacking in legitimacy.

4

Lessons learned

The findings from the *Lining Up* project make a substantial contribution to safety and improvement science. They have profound implications for quality improvement in general and infection control in particular. Here we present the key lessons about measurement that the project uncovered.

Beware comparisons

'We're always seeing league tables being produced, some with penalties attached,' says Professor Dixon-Woods. 'Our research suggests we can't be sure organisations are reporting the same things. Therefore we need to be much more cautious about attaching penalties and incentives on the basis of reported findings.'

Measurement is complex

'Setting up measurement systems for assessing quality of care is extremely complicated,' Professor Dixon-Woods says. 'The ICUs had very high-quality training provided and were given standardised definitions to report infections to a central database. Yet still they encountered great challenges. When we're asking them to count even more complex things we need to realise it's difficult, time-consuming and prone to error.'

Remember the human factor

Measurement is usually assumed to be a relatively simple technical procedure. But as Dr Elaine Maxwell, the Health Foundation's Assistant Director for Patient Safety, points out: 'Measurement is not a mathematical, natural science process. It's a social process. People do the measuring: it's not just putting something into a machine that churns out a number.'

Consequently measurement will be affected by human factors ranging from sophisticated manipulation to the mundane problems of co-ordinating files, forms, samples and lab procedures. *Lining Up* found that inconsistencies in reported data are more likely to arise from the mundane issues rather than, as had often been assumed, deliberate attempts to conceal through 'gaming'.

High-quality data collection is crucial

Lining Up has also underlined that good data collection is critically important for quality improvement. Without high-quality data, poor practice may be reinforced or improvements go unrewarded. With it, staff can be confident their efforts are recognised and their achievements are genuine. If staff do not accept a data collection system as legitimate, they will dismiss its findings, may remain unaware of problems and nothing will change as a result.

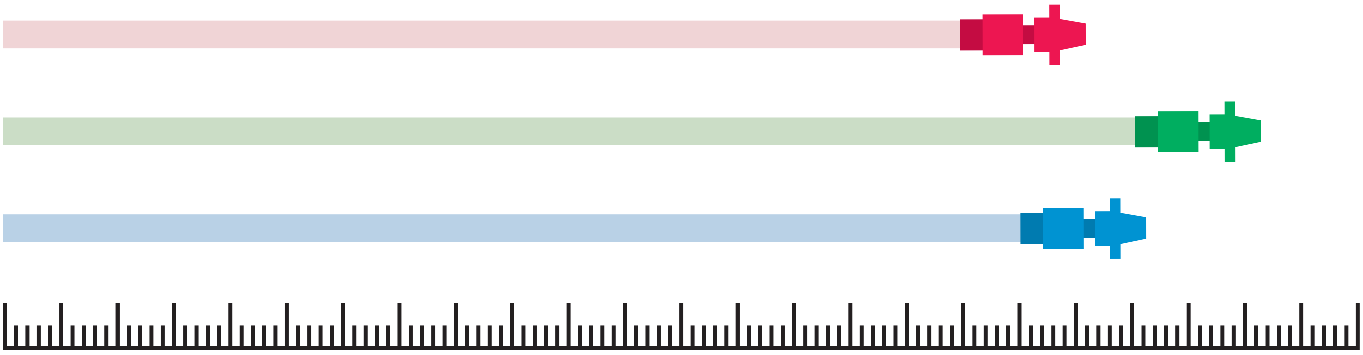
The research team stress that the closer you can link data collection to clinical priorities, the better it's likely to be.

Standard definitions are vital

A standardised, achievable approach and unambiguous definitions are also essential. Without these, organisations may produce inconsistent data of variable quality that will lack local credibility and be unable to bring about changes in culture and behaviour.

Implications for policy

The researchers argue that *Lining Up* has major implications for initiatives such as the Department of Health's QIPP (Quality, Innovation, Productivity and Prevention) programme and policy on 'never events'. CVC-BSIs are never events in the US, though not in the NHS. However, Professor Dixon-Woods says, 'The idea that you can completely eliminate CVC-BSIs from all clinical settings is not supported by the current evidence'.



Extending the research

The research now needs to be extended, Professor Dixon-Woods says. ‘I’d like to see this study replicated with other measures, so we can understand what people are doing when they’re counting falls or pressure ulcers, for example. We want to determine how to set up measurement systems that work.’

Conclusion

Lining Up discovered that the ICUs taking part in *Matching Michigan* were not counting the same things in the same way. The research highlights the complexity of apparently straightforward measurement tasks in quality improvement. It also calls into question the appropriateness of performance management regimes that base their application of rewards and sanctions on assumptions about the validity and comparability of data from different sites.

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