1 Introduction

Measurement is a key characteristic of any healthcare improvement effort. 'If you can't measure it, you can't improve it', is a widely quoted mantra, often attributed to engineer, statistician, and management pioneer Edwards Deming. It is true that Deming saw measurement as fundamental to improvement work. But what he actually said is rather different: 'It is wrong to suppose that if you can't measure it, you can't manage it – a costly myth'.[1,2] Deming recognised that management can occur on the basis of what we might now call qualitative signals or 'soft intelligence'.[3,4] In practice, most improvement interventions benefit from a mix of qualitative and quantitative measures – certainly during the development and refinement of an intervention and often in its eventual evaluation.

In this Element, we outline the major principles that underpin measurement related to healthcare improvement. We cover core concepts relevant to any measure (e.g. content and construct validity) and identify some unique problems that arise specifically in the context of measurement for improvement.

Although there is no single formula to guide us in how best to use measurement to support improvement, the importance of using multiple measures is crucial. Any improvement effort can succeed in several ways and go wrong in others. Moreover, contemporary definitions of quality identify distinct domains, including safety, effectiveness, patient-centredness, equity, and efficiency. No single measure (or probably even no measurement approach) can capture all the relevant intended and unintended consequences from any given intervention across multiple domains. Properly evaluating any improvement intervention usually needs a family of measures to overcome these challenges.

2 Measuring Healthcare Quality

The triad of structure, process, and outcome was first articulated by Avedis Donabedian in the 1960s,[5–8] and it remains the predominant model underpinning measurement of healthcare quality. Outcomes – from morbidity and mortality to functional status and the patient experience – are the bottom line for quality measurement. But outcomes are also a challenge for measurement. Mortality is easy to measure but doesn't represent the main outcome of interest for most improvement interventions. Harms short of death (i.e. morbidity) are more often relevant, but determining how many patients avoid key complications or achieve important functional outcomes is often far from straightforward.

2.1 Structural Measures

Donabedian pointed out that when connections exist between structural elements of care and patient outcomes of interest, it is possible to focus on the structural elements as they are often relatively easy to measure. For instance, an extensive literature shows associations between patient volume (i.e. the number of patients treated) and improved outcomes,[9] especially for surgical procedures.[10,11] Rather than measuring multiple outcomes after surgery, one might simply assess surgical volumes – as one prominent healthcare coalition in the United States has done.[12]

But this example highlights both the promise and potential pitfalls of structural measures: although they can be easy to measure and are usually easily understood by decision-makers and members of the public (e.g. 'practice makes perfect' for surgical volumes), structural aspects of care can be hard to change – and the benefits of doing so are far from guaranteed. Suppose, for example, that one hospital in a region becomes designated as the only one to perform certain complex cancer surgeries. It's not guaranteed that a several-fold increase in the number of patients at that hospital will immediately reproduce the good outcomes of centres that have performed this procedure at high volumes for many years. A rapid increase in patient volumes might even worsen care.

Also, the supporting evidence for most structural measures comes from observational studies potentially influenced by other factors. For instance, a substantial literature documents lower morbidity and mortality in hospitals where fewer patients are cared for by each nurse.[13,14] Such a relationship is extremely plausible, but it is also plausible that hospitals with better staffing levels are doing other things that are also conducive to improved patient outcomes.

2.2 Process Measures

Instead of depicting hospitals and clinics as black boxes with broad structural features, process measures take us inside the black box to capture the care patients actually receive. Process measures can include education and counselling (e.g. smoking cessation, encouraging physical activity), preventive care (e.g. age-appropriate vaccines, cancer screening), and provision of established medicines and surgeries. How these aspects of care are delivered can also count as process measures (Box 1).

One disadvantage of process measures, however, is that they are understood primarily by clinicians. The percentages of patients who received x, y, and z medicines or had a door-to-balloon time under 90 minutes have no obvious messages for patients. Table 1 lists commonly cited advantages and disadvantages

Box 1 Process Measures Related to Care Delivery

A large body of evidence shows that for patients with acute ST-elevation myocardial infarction (a heart attack with a completely blocked coronary artery), the best outcomes occur when the time from hospital arrival to performance of percutaneous coronary intervention (a procedure to open up blood vessels in the heart) does not exceed 90 minutes.[15] Similar evidence exists for thrombolysis for acute stroke, and as a result 'door-to-needle' time has become a common process-based target in efforts to improve the quality of acute stroke care.[16]

Delivering a given treatment can itself count as a process measure and so can the way it is delivered (e.g. its timeliness). A benefit of using process measures is that they identify targets for improvement more directly than outcome measures do, and they can do so fairly quickly. It might take years to see quality differences between hospitals using risk-adjusted (accounting for individual patient risk factors) mortality for patients with acute myocardial infarction; significant differences in the percentage of patients who receive recommended processes of care can become apparent within months.[17]

A hospital with a higher than expected 30-day mortality among patients with acute myocardial infarction will need to examine numerous potential contributing factors. But a hospital with prolonged door-to-balloon time – the time from arrival at the hospital to the patient undergoing the cardiac catheterisation procedure – will be clearer about where it needs to focus. Yet, processes of care themselves depend on multiple other processes. The hospital wanting to lower its door-to-balloon time needs to consider what paramedics do for patients in the field, aspects of care in the emergency department, how the cardiology team is activated, and so on.[18]

of process measures, though some do not withstand close scrutiny. For instance, outcome-based measures notoriously run into debates over the adequacy of adjustment for casemix – referring to the mix of patient characteristics and conditions that can influence outcomes. Process measures supposedly avoid that problem, but a similar problem can sneak in due to differences in potential exceptions or contraindications. For example, general practices judged on their rates of childhood vaccination might have different proportions of parents who choose for their child not to receive vaccines.

In addition, processes of care as measured may not capture the reality of process delivery. For instance, a typical note in a patient's medical record might mention 'patient counselled on smoking cessation'. A clinic could score very

Table 1 The triad of structure, process, and outcome for measuring healthcare quality

Approaches to assessment	Definition	Examples*	Advantages	Disadvantages
Structure	Attributes of the settings in which care occurs – e.g. infrastructure, human resources, availability of specific technologies and services, models of care, and organisational culture, among others.	Hospital size, teaching status, ownership. Availability of specific technologies and services. Staffing ratios and skill mix. Patient volumes. Clinical information systems. Organisational culture. Models of care (e.g. stroke units, closed intensive care units).	Efficient measurement. Captures aspects of care with the potential to affect multiple processes and outcomes of care.	Blunt. Often hard to change. Not always clear if change will produce improvement.
Process	The actions involved in delivering care, including those relating to screening, diagnosing, and treating.	Percentage of patients undergoing evidence-based cancer screening. Provision of proven medicines for patients with	Directly measures the care patients receive. Detects likely quality problems without having to	Often has little meaning for patients or decision-makers.

		acute myocardial infarction. Venous thromboembolism for hospitalised patients. Appropriate screening for retinal disease in patients with diabetes. Discussion of advanced directives and goals of care. Informed consent.	wait for poor outcomes to become apparent. Less sensitive to casemix differences than outcome measures. Directly suggests targets for healthcare improvement.	Accounting for legitimate exceptions can be deceptively challenging. Documentation not necessarily tied to the real process of interest (e.g. medical records document the prescriptions of interest, but there is no guarantee patients took the medicines as intended). Identification of targets for improvement not as straightforward as may appear (see text).
Outcome	Effects of care on the health status of patients and populations.	Mortality. Complications/morbidity. Patient Reported Outcome Measures (PROMs).	Meaningful to patients, providers, and decision-makers. Captures ultimate goal of measurement and improvement efforts.	Multiple factors influence outcomes. Adjustment for differences in casemix often challenging.

Table 1 (cont.)

Approaches to assessment	Definition	Examples*	Advantages	Disadvantages
		Patient Reported Experience Measures (PREMs). Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS).		Often require long observation periods to detect problems.

*The examples in Table 1 have been chosen for illustrative purposes on the basis of having been used as structural measures or their potential indicated for such use in the literature. This should not be taken as indicating a justified, well-established use in performance measurement.