Promotion of improvement as a science

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The remarkable achievements of modern health care make the deficiencies associated with delivery of care all the more noticeable. Health care is a major source of avoidable harm,[1,2] and patients are routinely exposed to wide and inexplicable variations in the quality of care that they receive.[3] These variations are very difficult to address, despite good intentions, policy focus, ambitious improvement programmes, and investment of resources.[4] A major reason for this difficulty is that the urge to act can easily overwhelm the need for evidence to inform that action, to the extent that much quality improvement work is unscientific[5]—it is neither informed by high-quality evidence, nor is it subject to rigorous assessment to establish its effectiveness, costs, and risks. Ironically, this absence of a scientific approach might lead to outcomes that are exactly the opposite of what is intended by improvement efforts: resources can be wasted, energy and enthusiasm are dissipated, the side-effects of interventions are ignored, and little positive change is evident. Adoption of a more scientific approach to improvement has great potential to enhance the ability of health systems to provide high-quality care and optimise resource use.

We believe that the science of improvement is in what Kuhn[6] calls the pre-paradigm phase of the emergence of a new discipline, one of the characteristics of which is the absence of an agreed definition. Attempts to create a definition can trigger intense debate, and the term improvement science has so far eluded consensus.[7] Don Berwick and the Institute of Healthcare Improvement in Boston (MA, USA)[8] have influenced one of the most common uses of this term, which is to describe applications of the approach developed by W Edwards Deming to reduce variation in industrial processes.[9] The quality improvement movement associated with these methods has made a valuable contribution, not least in challenging overly technocratic, managerialist, or regulatory-focused approaches to change. However, this conceptualisation of a science of improvement is, by itself, too narrow and restrictive to address the challenges that face the health sector, and too often under-emphasises robust assessment. Perception of improvement solely in terms of implementation and comparative effectiveness research is similarly inadequate.[10]

An example of a benefit of a broader way of thinking is the reduction of central line bloodstream infections in intensive-care units. These infections are a substantial and expensive clinical problem, and are often fatal. A cohort study of 103 intensive-care units in Michigan, USA, showed that a multicomponent programme of evidence-based technical interventions, adaptive interventions targeting culture and systems, and a centralised data collection and feedback system resulted in a substantial reduction in rates of these infections.[11] These reductions were sustained over time and were associated with reduced mortality in participating intensive-care units compared with control units.[12] The results have been replicated in 22 additional US states. Follow-up work investigated the mechanisms through which the programme worked, and generated a theory of change that could inform, and be tested in, subsequent repetitions of the programme.[13]

Another example of a benefit of this broader way of thinking is the increase in identification and referral of victims of domestic violence. Domestic violence is often managed inadequately, despite the major health and social implications of unidentified and unmanaged abuse. In a cluster-randomised controlled trial in 51 primary care clinics in two UK cities (London and Bristol),[14] investigators tested a range of evidence-based interventions to increase rates of primary care identification and referral to specialist advocacy services of women subjected to domestic violence. The results showed three-times more recorded disclosures of domestic violence and a 22-times higher number of referrals to specialist services in the intervention group. The interventions, in the form of targeted educational programmes, are now being adopted in several places in England.[15]

These examples show some distinguishing features of a broader definition of improvement science. Improvement science aims to create practical learning that can make a timely difference to patient care. It is characterised by its large domain of interest, its applied nature, and its commitment to generation of practical learning that can be applied in real-life situations. Improvement science recognises and integrates many contributions, similar to the way that engineering science uses scientific knowledge and theories to address real-life problems.

Improvement science also aims to generate local wisdom and generalisable or transferable knowledge, with robust, well established research methods applied in highly pragmatic ways. Improvement science enables local improvement and, crucially, produces knowledge with external validity. Thus, work classified as improvement science should be of sufficient quality to be published as a long-lasting, widely disseminated record in well-respected journals. Development of local knowledge based on a strong sense of ownership and a willingness to adapt improvement activities is clearly important, but too many quality improvement projects rely on contemporaneous, non-standardised, unverified data to make judgments about their effectiveness. By contrast, the science of improvement is, based on moral and practical requirements,[16] characterised by its commitment to rigorous and credible assessment methods

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and use of high-quality data. However, its choice of methods is often guided by pragmatism and by the difficult reality of the implementation of interventions and data collection in complicated, highly heterogeneous, real-life clinical situations.

Improvement science needs a genuine partnership between academics and front-line practitioners. Researchers bring scepticism, scientific rigour, and methodological technical expertise, whereas practitioners bring content knowledge, a thorough understanding of working contexts, and practical wisdom. Academics and service partners need to collaborate to design, undertake, and interpret the work of improvement science. Progression beyond the constraining boundaries of traditional health services research or quality improvement work can help to create new boundaries of traditional health services research, and quality improvement work can help to form new synergies and release creativity alongside rigour. Partnerships between researchers and practitioners and between different disciplines should be authentic relationships between equals, and no group should be seen as subordinate or as the servant of the other. These partnerships should entail mutual support and healthy challenge, rather than jealous guarding of territorial domains.

Improvement science draws on, and aims to contribute to, clear and explicit theories of how change happens. A major component of improvement science focuses on the design, deployment, and assessment of complex, multifaceted interventions. Good theory, both the small theories[17] of individual programmes and the big theories of making change happen, is just as essential to improvement science as are good methods. In view of the challenges in tackling the complexities of modern health care, the fact that these theories are drawn from a range of disciplines (from clinical epidemiology and engineering through to psychology and sociology) is beneficial. Theory clarification would help to address the problem that improvement interventions are often designed without the benefit of previous learning or explanation of the assumptions about how and why change is likely to occur. Consequently, many quality improvement interventions are black boxes that are difficult to reproduce in new contexts. Improvement science now needs to start the difficult task of the systematic accumulation and synthesis of knowledge; improvement projects deteriorate and become less effective when they ignore the rapidly developing evidence base in the field.

Improvement science shows a genuine ethical commitment to patient benefit and to collaborative learning. Recent work has emphasised the importance of learning as an ethical commitment in health care.[16,18] Improvement science embraces this commitment: front-line practitioners deserve high-quality evidence on which to base their efforts to treat patients, and their learning should be shared with others. By integrating science with clinical priorities, by bringing together those who care for patients and those who study that work, and by committing all those involved to the same values, the science of improvement has great potential to benefit patients.[19]

A strategic approach is needed to optimise the impact of improvement science. First, the policy, service, and academic communities need to learn about improvement science, the synergistic relation between this science and the more familiar biomedical and clinical sciences, and how the science can be used to make a difference to patient care. An agreed curriculum is needed to achieve this education. Moreover, academia needs to break out of rigid and unhelpful departmental silos and work in interprofessional research and practice teams; incentives are needed to encourage this cooperation. Second, capacity and capability need to be built at all levels from improvement science leaders to front-line staff. Third, the counter-cultural nature of improvement science for traditional service and academic sectors should be recognised and space provided to develop new ways of thinking and acting. This aim will need a redefinition of some of the success criteria in both the academic sector (in which the desire to make a practical difference is rewarded only rarely) and the service sector (in which the development and application of scientific evidence is not always highly regarded). Fourth, the creation of an international network or body to support the emerging science and help improvement scientists to share knowledge would help to ensure that the science develops as an outward-looking endeavour, in the same way as the Cochrane Collaboration helped to secure the foundations of evidence-based medicine. Finally, funding is needed to establish and support centres for improvement science, and bring together diverse academic and clinical disciplines within discrete health economies. If this strategy is successful, within the next decade the science of improvement will become an essential component of high-quality care for patients.

Contributors
MM had the original idea for the paper and all authors developed the content. MM wrote the first draft of the paper, and PP and MD-W adapted and revised this draft. MM is the guarantor.

Conflicts of interest
We declare that we have no conflicts of interest.

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References

1 de Vries EN, Ramrattan MA, Smorenburg SM, Gouma DJ, Boermeester MA. The incidence and nature of in-hospital adverse events: a systematic review. *Qual Saf Health Care* 2008; **17:** 216–23.
2 Landrigan CP, Parry GJ, Bones CB, Hackbarth AD, Goldmann DA, Sharek PJ. Temporal trends in rates of patient harm resulting from medical care. *N Engl J Med* 2010; **363:** 2124–34.
3 QIPP/Right Care. NHS atlas of variation in healthcare 2011. http://www.rightcare.nhs.uk/index.php/atlas/atlas-of-variation-2011/ (accessed Dec 3, 2012).
4 Wachter RM. Patient safety at ten: unmistakable progress, troubling gaps. *Health Aff (Millwood)* 2010; **29:** 165–73.

5 Auerbach AD, Landefeld CS, Shojania KG. The tension between needing to improve care and knowing how to do it. *N Engl J Med* 2007; **357:** 608–13.

6 Kuhn TS. The structure of scientific revolutions. Chicago: University of Chicago Press, 1962.

7 The Health Foundation. Improvement science research scan. London: The Health Foundation, 2011.

8 Berwick DM. The science of improvement. *JAMA* 2008; **299:** 1182–84.

9 Varkey P, Reller MK, Resar RK. Basics of quality improvement in health care. *Mayo Clin Proc* 2007; **82:** 735–39.

10 Alexander JA, Hearld LR. The science of quality improvement implementation: developing capacity to make a difference. *Med Care* 2011; **49** (suppl)**:** S6–20.

11 Pronovost P, Needham D, Berenholtz S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. *N Engl J Med* 2006; **355:** 2725–32.

12 Pronovost PJ, Goeschel CA, Colantuoni E, et al. Sustaining reductions in catheter related bloodstream infections in Michigan intensive care units: observational study. *BMJ* 2010; **340:** c309.

13 Dixon-Woods M, Bosk CL, Aveling EL, Goeschel CA, Pronovost PJ. Explaining Michigan: developing an ex post theory of a quality improvement program. *Milbank Q* 2011; **89:** 167–205.

14 Feder G, Davies RA, Baird K, et al. Identification and Referral to Improve Safety (IRIS) of women experiencing domestic violence with a primary care training and support programme: a cluster randomised controlled trial. *Lancet* 2011; **378:** 1788–95.

15 Abbasi K. Improvement in practice: the IRIS case study. London: The Health Foundation, 2011.

16 Faden RR, Beauchamp TL, Kass NE. Learning health care systems and justice. *Hastings Cent Rep* 2011; **41:** 3.

17 Lipsey M. Theory as method: small theories of treatments. In: Sechrest P, Perrin E, Bunker J, eds. Research methodology: strengthening causal interpretations of non-experimental data. Washington: Agency for Health Care Policy and Research, 1990: 33–51.

18 Institute of Medicine. Best care at lower cost: the path to continuously learning health care in America. Washington: National Academies Press, 2012.

19 Shojania KG, Grimshaw JM. Evidence-based quality improvement: the state of the science. *Health Aff* 2005; **24:** 138–50.