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Research article

Qualitative analysis of multi-disciplinary round-table discussions on the acceleration of benefits and data analytics through hospital electronic prescribing (ePrescribing) systems

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ABSTRACT

Background Electronic systems that facilitate prescribing, administration and dispensing of medicines (ePrescribing systems) are at the heart of international efforts to improve the safety, quality and efficiency of medicine management. Considering the initial costs of procuring and maintaining ePrescribing systems, there is a need to better understand how to accelerate and maximise the financial benefits associated with these systems.

Objectives We sought to investigate how different sectors are approaching the realisation of returns on investment from ePrescribing systems in U.K. hospitals and what lessons can be learned for future developments and implementation strategies within healthcare settings.

Methods We conducted international, multi-disciplinary, round-table discussions with 21 participants from different backgrounds including policy makers, healthcare organisations, academic researchers, vendors and patient representatives. The discussions were audio-recorded, transcribed and then thematically analysed with the qualitative analysis software NVivo10.

Results There was an over-riding concern that realising financial returns from ePrescribing systems was challenging. The underlying reasons included substantial fixed costs of care provision, the difficulties in radically changing the medicines management process and the lack of capacity within NHS hospitals to analyse and exploit the digital data being generated. Any future data strategy should take into account the need to collect and analyse local and national data (i.e. within and across hospitals), setting comparators to measure progress (i.e. baseline measurements) and clear standards guiding data management so that data are comparable across settings.

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Conclusions A more coherent national approach to realising financial benefits from ePrescribing systems is needed as implementations progress and the range of tools to collect information will lead to exponential data growth. The move towards more sophisticated closed-loop systems that integrate prescribing, administration and dispensing, as well as increasingly empowered patients accessing their data through portals and portable devices, will accelerate these developments. Meaningful analysis of data will be the key to realise benefits associated with systems.

Keywords: data analytics, ePrescribing, returns on investment

INTRODUCTION

There is considerable international interest in relation to health information technologies (HITs) in order to improve the quality, safety and efficiency of care.[1–4] Evidence of effectiveness of these systems, however, is often equivocal, particularly in relation to their impact on patient outcomes and financial returns.[5] Underlying reasons may include the infrastructural characteristics of HITs, and the fact that their diffuse effects are often hard to trace and predict in advance.[6,7] Establishing a causal link between HITs and patient outcomes is extremely difficult, and changes in business processes brought about by such transformative implementations can mean that baseline comparisons are close to impossible. In addition, benefits may not appear as a direct consequence of implementation. They may result from later benefit realisation efforts that pursue health pathway improvements from the information collected or the scope for further extension of systems. As a result, there may be a problem in attributing improvements to the investments in the core infrastructure. Other underlying factors may relate to the difficulty measuring non-financial benefits. Returns on investments (RoIs) are typically calculated by weighing up financial investments against resulting benefits, but these benefits are not necessarily financially measurable (e.g. patient experience) and not all risks may adequately be taken into account (e.g. adverse effects on work practices).

Electronic systems that help hospitals manage prescribing, administration and dispensing of medication (or ePrescribing systems) represent a relatively direct link between the technology and prescribing/clinical outcomes. They are therefore a good starting point to begin exploring benefits and costs.[5] They are, however, expensive, both in terms of startup and maintenance.[8] Consequently, as a result of the considerable cost investment required and at a time when health systems are financially struggling, there is a substantial interest in how to maximise financial RoIs. For example, the predicted £2.5 billion deficit in the U.K. National Health Service (NHS) is a problem that needs to be addressed and central to this is the financial performance of hospitals.[9] However, hospitals and policy makers are by no means alone in wanting to demonstrate financial benefits. Industry has long-standing interest in this area and has been very successful at scaling and measuring system optimisation approaches (i.e. refining systems and ensuring that they realise anticipated benefits) in sectors including media and communications, banking and retail. For example, the banking industry has made significant leaps in developing and implementing mobile banking services, which are estimated to have resulted in a 15.7 % RoI.[10]

Central to these efforts are increasingly technology investments in ‘Big Data’ that allow organisations to analyse large volumes of information and use this information for efficiency and quality improvements.[11] Data analytics (i.e. reusing data for managerial purposes) therefore also represents a major opportunity for realising financial benefits of HITs, a development that is supported by some pioneering health systems that draw on secondary uses of data to realise financial returns.[12–15]

Given the paucity of international evidence on this subject,[5,16] we convened an international expert multi-disciplinary group to explore how different sectors are approaching the realisation of RoIs from ePrescribing systems in U.K. hospitals and what lessons can be learned for future developments and implementation strategies within healthcare settings.

METHODS

Ethics and consent

The work was reviewed by the Nursing Studies Ethics Review Panel at The University of Edinburgh (UK) and received approval in November 2014. Participants gave written informed consent to participate in the discussions. Names and places were anonymised when reporting data in order to protect the anonymity of participants.

Design

We conducted multi-disciplinary round-table discussions, which were organised as a series of focus groups with two designated facilitators (JC and CS) with clinical backgrounds.[17] As we deliberately tried to explore cross-sector experiences and stimulate the exchange of ideas, this interactive format of qualitative data collection was deemed most appropriate.

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Sampling and recruitment of participants

Our sampling strategy was purposeful.[18] As part of related work evaluating the introduction of ePrescribing systems in English hospitals,[3] we have been populating a list of national and international leading figures with experience of, or interest in, implementing/using ePrescribing systems. In line with our aims, we initially divided potential participants into sectors including representatives from policy (with the aim to get insights into current and future policies), healthcare organisations (aiming to draw on their experiences and exploring the practical feasibility of discussed options), academic researchers (drawing on theoretical insights and future work), patients (investigating potential impacts on perceived care and related concerns), and industry (seeking to learn from experiences in other settings). We approached prescribing software companies that either had a significant market share in the U.K. already or were beginning to establish themselves in the U.K. market. The leading organisations were then listed and invitations to the most senior figures were sent out initially (targeting chief executives in the first instance). In some cases (no = 3), our email was then passed on to the organisational representative that was deemed most appropriate. We invited 31 individuals, of whom six did not respond to our invitations. A further four agreed to participate, but did not attend on the day, due to extenuating circumstances.

Setting

The series of round-table discussions took place at The University of Edinburgh, U.K. in February 2015. The room was set up in boardroom style. One international participant dialled in via Skype.

Data collection and handling

The event was arranged around four topic areas, which were divided into two parts (see Box 1): 1) maximising benefits and RoIs and 2) data analytics. The topic guide was developed jointly by the authors and was sent out to participants for comments before the event, which resulted in minor modifications (mainly relating to more detailed areas of discussion).

Box 1 Key topics discussed

PART 1: Maximising benefits and RoIs

Topic I: What are the potential RoIs from ePrescribing and related systems?

Topic II: How can RoIs identified in Topic 1 be accelerated/maximised?

PART 2: Data analytics

Topic III: Current analytics infrastructure, expertise and approaches

Topic IV: Looking ahead: future developments in software, data linkage and analytics

One facilitator (CS) led the first part of the discussions, whilst the other (JC) led the second part of the discussions. Each session began with a brief introduction of the topic followed by subsequent dialog by participants. By prompting participants who had not spoken at the end of each topic, facilitators helped to ensure that a range of viewpoints was heard. A coffee break between the two sessions helped participants to more informally exchange experiences and facilitated networking.

We audio-recorded the event and transcribed the recordings verbatim. In addition, a researcher (KC) took field notes on the speakers and the observed dynamics to aid interpretation of results. Audio recordings were transcribed by a professional transcriber, checked for accuracy by a researcher (KC) and uploaded into NVivo10 software for analysis.[19]

Data analysis

Verbal data were initially coded along the four topic areas by KC (the deductive element).[20] As special attention was paid to capturing emerging themes (the inductive element),[20] these were created as the researcher examined the transcripts in more detail to reflect recurring issues in the discussions. Attention was also paid to capturing points relating to different perspectives on the same phenomenon (as a variety of backgrounds represented were an important design feature). Theoretically, we drew on the work surrounding information infrastructures. This helped us to examine the technological dimension surrounding the uses and reuses of digitised health data.[21] Information infrastructures are characterised by distributed linked technologies that support information sharing/analysis on large scales and between settings. They also tend to have a multiplicity of users and uses, which extend beyond those anticipated in initial design. As a result, information infrastructures pose a very different set of technological challenges than more discrete technologies (e.g. in relation to ease of use, integration of systems).

Results of this initial analysis were fed back to the research team and subsequent discussions helped to refine themes and subthemes. This refined set of results was then fed back to attending participants for comments, which lead to minor modifications mainly in relation to the level of detail in subthemes.[22]

Results

Twenty-one participants took part in our discussions. These included participants representing a variety of sectors (see Box 2).

Box 2 Characteristics of participants

5 females and 16 males
4 NHS pharmacists
5 prescribing software company representatives (4 national and 1 international)
4 academics
2 policy representatives
2 industry representatives
1 NHS consultant
1 pharmaceutical company representative
1 innovation centre representative
1 patient

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The following key themes emerged from these discussions (Box 3):

- Inadequate capability to collect and analyse existing financial data
- Achieving improvements in safety, quality of care and organisational efficiency
- Developing a national data strategy to allow analysis of generalised data
- Looking ahead: capturing and real-time analysis of data to predict care pathways.

These will be examined in detail below.

Box 3 Summary of themes

Inadequate capability to collect and analyse existing financial data
- Direct financial benefits and efficiency savings are hard to identify and measure
- Anonymisation of data and accessibility
- Insufficient appropriate infrastructure and resources to collect and meaningfully analyse data

Achieving improvements in safety, quality of care and organisational efficiency
- Using ePrescribing systems to improve safety, quality and efficiency
- More efficient capturing and analysis of data by 'doing simple things well'
- Engaging users and organisations through data availability and easy-to-use tools
- Learning lessons

Developing a national data strategy to allow analysis of generalised data
- The difference between specific and generalised data
- A national data strategy with data standards and access arrangements
- A gold standard against which progress can be measured

Looking ahead: capturing and real-time analysis of data to predict care pathways
- Exponential growth in data
- The continuing rise of portable technologies
- Predictive data analytics applied to care pathways including medicines management
- Robust commercial and research partnerships

Inadequate capability to collect and analyse existing financial data

Participants agreed that direct financial benefits and efficiency savings resulting from the introduction of ePrescribing systems were not only hard to identify but also hard to quantify. The underlying difficulty was perceived to be the fact that many observed system benefits were qualitative in nature, such as improvements in value to patients, which resulted in difficulties measuring quantifiable benefits and calculating financial returns. A related issue was that existing financial benefits were not cash releasing, and hence hard to trace.

> *'…you struggle with what are the benefits and sometimes, you can see the clinical benefits but…the direct financial benefits are actually very interesting… I'm sure there are endless financial benefits indirectly.'* Participant 12, NHS Pharmacist

Another factor inhibiting meaningful analysis of quantitative evidence and calculation of efficiency savings was an inadequate infrastructure and associated resources for data analytics within the NHS. This not only included financial resources to support system procurement and implementation, but also a lack of data analytics and benefits realisation expertise within hospitals. For example, an inadequate understanding of current processes and attached costs was a frequently mentioned barrier to estimating potential RoIs.

> *'…we pay people fixed amounts of money for each procedure they do, so it's kind of important that we understand whether or not that has any relationship with cost, but about 50% of the hospitals are basically clueless, I mean literally clueless as to what the return costs are.'* Participant 7, Industry

Similarly, it was felt that managers within the NHS would put in capital investment for systems and then expect them to deliver, but participants from NHS hospitals that had implemented these systems argued that in reality systems needed to be 'nurtured', in terms of constant refinement and relationships with suppliers, to really deliver benefits. This aspect of longer-term support for system optimisation was often seen to be underestimated and underappreciated in the NHS.

> *'…the NHS tends to think of putting in an eHealth system as what I would call 'Wash and Go', you put them in and you walk away and you just don't do that, you have to nurture them.'* Participant 1, NHS Pharmacist

Anonymisation of data and accessibility arrangements were also discussed as important challenges to tracing benefits, as they may inhibit meaningful analysis of inter-organisational data and prevent the NHS from exploiting existing datasets for maximum benefit. A more altruistic sharing of personal data amongst patients was viewed as an important facilitator and being able to trace data back to individual users (e.g. clinicians) and patients was seen as a fundamental pre-requisite to achieving maximum benefits.

> *'The biggest challenge that I see in the NHS is ownership of data, if people could actually find who owns the data then actually the [technological] tools are there, you know infinite cloud computing capabilities, machine learning to take insight from your data and give predictive outputs...'* Participant 3, Researcher

Achieving improvements in safety, quality of care and organisational efficiency

Despite the issues outlined above, participants agreed that ePrescrbing systems offered a significant potential for decreasing the costs of care provision. Representatives from some pioneering U.K. institutions present outlined several

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categories of benefits, although these were proxies for financial benefits in discreet areas.

These included:

- Clinical benefits: e.g. reduced omitted doses, more medicines given on time, more efficient prescribing through clinical decision support and computerised order entry systems (e.g. formulary switching), reduced prescribing errors, improved legibility, linking medications to clinical pathways, and antimicrobial stewardship
- Operational benefits: e.g. through secondary uses of data surrounding drug usage/expenditure, reduction in waste, quicker discharge process, and time savings for staff
- Managerial benefits: e.g. historical data for quality improvement by reviewing clinical management of patients and creating learning organisations, facilitating audits, and enhanced ability for workforce management.

However, none of these organisations had a closed-loop system (i.e. one that manages, dispenses and administers),[23] which may have prevented them from realising maximum benefits associated with barcode patient identification, integrated patient-specific details, medication administration, and automated dispensing. Such closed-loop approaches are more advanced, more complex and more expensive to implement, as they affect many different areas of organisational functioning.

At an organisational level, participants discussed the necessity to move from these proxies towards measuring more direct financial impacts through more efficient capturing and analysis of data. The best way for implementation teams within the NHS to achieve this was argued to be by 'doing simple things well', that is, by devising tools that facilitate the recording and analysis of data without being too time consuming for users, technologically complex or expensive. A similar argument for simplicity was expressed in relation to measurements of quality, with participants arguing for a need to focus on a limited number of quality indicators when measuring system impacts.

> *'The most important thing I remember was: less is more… define very carefully what you want to improve because too much information – nobody will read, nobody will understand.'* Participant 17, Industry

Engaging users (e.g. doctors, nurses and pharmacists), who were arguably instrumental in ensuring data availability and quality, was seen as a central component of an organisational move towards meaningful analysis of data. Incentives were seen to include individual access to data and associated personalised tailored analytic feedback, for example in relation to an individual's clinical performance. This was also seen as a potential means to help bridge the gaps relating to maximising use and differences in perceived benefits between users, management, and data analysts.

Learning optimisation-related lessons from other healthcare organisations and from internal ventures was viewed as an important component on the way towards meaningful analysis of data, in order to direct existing efforts, anticipate benefits and measure these more effectively. However, there was a perceived lack of sharing practice in the NHS, particularly if these were innovative.

Developing a national data strategy to allow analysis of generalised data

Participants highlighted the importance of differentiating between using data for specific and for generalised purposes. Whilst organisational improvements and analysis discussed above were seen as central to realising local organisational benefits, there was also a perceived need to begin approaching the measurement of national returns through larger-scale data analytics and linkage across care settings.

A generalised analytics infrastructure was seen as central to achieving this. Participants argued that this should include a national data strategy with specified data standards, allowing integration of data across settings, and helping suppliers to develop interoperable systems and adequate analytics tools.

> *'I think the connecting thing in there is a data map or a data strategy… until we do that from the top down we'll always end up with project based type data.'* Participant 15, Innovation Centre

As part of a national data strategy, participants also called for the development of a 'gold standard' of organisational processes against which individual organisational progress could be measured. As currently organisational processes vary significantly and are often not well documented, this would benefit organisations in helping to measure local benefits and help to build a more integrated national analytics infrastructure.

> *'I think one of the things that I have personally struggled with is, before you can measure return on investment you have to find out what is the ideal way.'* Participant 17, Industry

Looking ahead: capturing and real-time analysis of data to predict care pathways

In the future, an exponential growth in data was expected with a range of clinical users and patients themselves collecting information through increasingly portable technologies. A partnership with commercial companies and academia to analyse these increasing amounts of data was, in light of the lack of resources and expertise within the NHS outlined above, viewed as a viable future option. Some such partnerships existed between the NHS and the pharmaceutical industry, but participants highlighted that there was a significant potential for this to work on larger scales and with other industries.

A representative from the pharmaceutical industry described such a joint venture as follows:

> *'…we're providing resource in terms of analytics to actually validate the [NHS] datasets…and that feeds our ability to price our medicines in the future according to indications. So that's why we're doing it…what they*

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[the NHS] are getting is reports that they want at the Trust level…so we can provide them with bespoke analytics using a resource that we're paying for. That drives up the data quality and it fulfils our need in the future...' Participant 13, Pharmaceutical Company

Overall, the NHS was seen to be far behind commercial industries in terms of data analytics capability. Contributing to this was the lack of leadership, the difficulty engaging users and the limited resources and expertise discussed above. In addition, participants stated that the NHS often neglected the content or presentation of data (where available), which was perceived to reduce the value of that information. Technological limitations were not perceived to hamper efficient exploitation of data in the NHS.

As some promising future developments resulting from an increasing amount of data, participants referred to recent advances in machine learning and predictive data analytics that could be applied to prescribing. These were seen to potentially involve drawing on algorithms for predictive modelling, particularly in relation to minimising the risk of hospital admission and readmission in those with long-term conditions.

'As you start to accumulate a set of records about a patient and their health over some time, we have algorithms that can predict what is your health going to look like in five years and what types of choices might you make as a patient that could change what your health looks like in five years.' Participant 21, Prescribing Software Company

DISCUSSION

There was a general lack of clarity amongst participants as to how financial returns from ePrescribing systems could be realised and measured, although a range of qualitative benefits from systems were reported in hospitals that had already implemented. Data analytics was viewed as an area with significant future potential. Hampering progress in this area was the fact that the NHS lacked appropriate resources and expertise to meaningfully analyse ePrescribing data, but also a lack of central guidance in relation to the collection, aggregation and analysis of localised and generalised datasets.

The range of sectors represented in this work is a clear strength, which was also reflected in the vibrant discussions and the enthusiastic feedback of participants. Participants were highly motivated to attend a discussion of what they perceived to be an important topic. Our results have real policy significance relating to current and future strategies. Nonetheless, there are also some important limitations, including finding the right balance of the number of participants. We aimed at maximum sector representation, but this resulted in a large number of stakeholders being present. Due to the large group, not everyone may have been able to voice all their concerns as they may not have had the chance to contribute. In addition, the facilitators were not trained qualitative researchers, but they did have credibility amongst participants as they are well-known figures in the area. Other limitations of this work include the relatively small number of participants, which may limit generalisability of findings; the lack of representation from some sectors and professions (e.g. junior doctors, nurses) and the limited time, which may have prevented some of the topics from being explored in sufficient depth. Nevertheless, we have provided important qualitative, experiential data in an emerging field.

A range of policy recommendations emerge from this work, which we have summarised in Box 4. Central to these is the development of a more coherent national data strategy taking into account the use and reuse of data held within systems to help organisations realise benefits and facilitate the collection of national datasets. ePrescribing systems lend themselves well to these deliberations, as they require digital transformations that transcend organisational and professional boundaries. The data collected through ePrescribing systems therefore have a range of potential individual, organisational and national applications.

Box 4 Policy recommendations for the U.K. emerging from this work

A more coherent national data strategy, facilitating the use and reuse of localised and generalised data

Identify meaningful proxies for measuring RoIs and applying these to a 'gold standard' that is nationally agreed and locally applied

Identifying the range of data that need to be the focus of short-, medium- and longer-term analyses for local and national efforts

Identify future technologies with the highest potential benefits and invest in future developments whilst harnessing the technologies that are already implemented

Deliberate potential risks relating to future uses of localised and generalised data and develop a strategy to mitigate these

As we have seen, participants advocated the development of agreed organisational processes against which individual organisational progress could be measured. Some of this work has already begun through the efforts of analytics companies such as the Health Information and Management Systems Society. This is a not-for-profit organisation that measures hospitals' progress towards achieving a 'gold standard' of HIT implementation, commonly conceptualised as healthcare organisations drawing on electronic data to improve safety, quality and organisational efficiency.[24] In relation to ePrescribing, this gold standard would consist of a closed-loop system that would allow effective secondary uses of data to improve performance, advanced refinement of decision support tools through integration with clinical notes, and increased automation resulting in less need for human involvement (e.g. in relation to dispensing). However, although some local hospitals draw on this work, there is to date no central guidance on incorporating such achieve-

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ments in the U.K. This stays in stark contrast to U.S. policy, where, due to the different health system and financial arrangements, achieving this level of integration is a central aim of governmental efforts.[1]

It is also important that any future strategy is cognisant of the exponential growth of data and increasing number of devices to collect these data. ePrescribing systems generate data collected by a range of professions (doctors, nurses, pharmacists and allied health professions) through a number of means, including handheld devices, desktops and computers on wheels. A data strategy will need to consider what range of data should be the focus of short-, medium- and longer-term analyses, as organisations may get overwhelmed by the sheer amount of possibilities available and are likely to have limited resources. ePrescribing analytics priorities may, for instance, involve important issues surrounding antimicrobial stewardship, which is now high on local and national agendas and has the potential to affect a range of professional and organisational behaviours.[25] Such a work will also have to involve considering the related issue of local and national data analysis resources. New career pathways (e.g. specialist training) will have to be developed to promote data analytics expertise within the NHS and a discussion surrounding the potential exploitation of collected data through third parties (such as pharmaceutical companies) is an area rife for discussion.

Participants have alluded to the exciting opportunities presented through the ever-growing range of technologies. Whilst important to harvest new prospects (such as, for example, the role of artificial intelligence to diagnose disease, which has been shown to outperform humans in patient outcomes and cost),[26] it is also important to concentrate on optimising existing technologies. This is particularly true in light of the findings that socio-economic returns from complex health technologies are likely to take a long time to materialise.[27] Any future strategy will have to take these long timelines into account and should aim to develop meaningful measurements of potential RoIs, drawing on existing international expertise. ePrescribing systems are just at the beginning of the optimisation journey, which is likely to be an ongoing venture.[28]

Our participants outlined several categories of benefits, but these were proxies for financial benefits in discreet areas. Similar issues measuring direct financial impacts are faced by the international community, where financial returns may be discovered (possibly as a result of better data availability), but measured through proxies such as prescribing and medication guidance provided by the system, improved compliance to guidelines, better legibility, time savings of healthcare professionals, and prevention of adverse drug events.[29,30]

The work surrounding information infrastructures, which draws on other industries, can help us to understand the challenges surrounding potential future scenarios of ePrescribing systems in more detail. These may include the standardisation of data formats, considerations surrounding access methods, implications for users when navigating additional interfaces that connect systems for aggregating data, aligning different long-term goals between stakeholders to achieve sustainability, devising security systems, and legal implications, and intellectual property considerations (e.g. surrounding locally developed analysis methods and systems). As has previously been argued, these aspects need to be taken into account when considering how data are exchanged on large scales, as they can hinder effective sharing and analysis.[21] For example, as our participants have argued, discussions surrounding anonymity do not feature in commercial discussions surrounding 'Big Data', but anonymity and security represents a real ethical problem for healthcare systems. We therefore need to view healthcare systems (including ePrescribing) as potentially even more complex information infrastructures than those already in place in other sectors. Similarly, management of information infrastructures needs to take into account a wider range of considerations than in some other sectors. These may, for instance, relate to long-term developments and formats of information. ePrescribing systems will generate data over long periods of time and are likely to be replaced with new technologies.[31] As a result, they will generate data in different formats that will need to be integrated.

CONCLUSIONS

This work is an important starting point relating to considerations surrounding the realisation of financial returns from ePrescribing systems and data analytics. The range of stakeholders and motivations represented has contributed towards developing a comprehensive perspective.

Although explored in the context of a publicly funded health service, there are also some transferable lessons for privatised systems, particularly surrounding the management of increasingly complex information infrastructures. Financial benefits can be accelerated if data are aggregated across settings and this remains an international challenge, particularly in privatised health systems where incentives for larger-scale aggregation are often limited for individual providers. The issue will become more pressing with time, as we collect increasing amounts of electronic data with a growing range of devices. The need to justify expenditures will remain as pressures on health systems are likely to increase.

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Competing interests

All authors declare that they have no competing interests.

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