

Research article

Creating a climate that catalyses healthcare innovation in the United Kingdom – learning lessons from international innovators

Kathrin M. Cresswell

Usher Institute of Population Health Sciences and Informatics, The University of Edinburgh, UK

Sarah Cunningham-Burley

Usher Institute of Population Health Sciences and Informatics, The University of Edinburgh, UK

Aziz Sheikh

Usher Institute of Population Health Sciences and Informatics, The University of Edinburgh, UK

Cite this article: Cresswell KM, Cunningham-Burley S, Sheikh A. Creating a climate that catalyses healthcare innovation in the United Kingdom – learning lessons from international innovators. *J Innov Health Inform.* 2016;23(4):772–782.

<http://dx.doi.org/10.14236/jhi.v23i4.882>

Copyright © 2016 The Author(s). Published by BCS, The Chartered Institute for IT under Creative Commons license <http://creativecommons.org/licenses/by/4.0/>

Author address for correspondence:
Kathrin M. Cresswell
Usher Institute of Population Health Sciences and Informatics, The University of Edinburgh
Edinburgh, UK
Email: K.Cresswell@ed.ac.uk

Accepted December 2016

ABSTRACT

Background The United Kingdom (UK) lags behind other high-income countries in relation to technological innovation in healthcare. We sought to understand what national strategies can help to promote a climate for innovation in healthcare settings by extracting lessons for the UK from international innovators.

Methods We undertook a series of qualitative semi-structured interviews with senior international innovators from a range of health related policy, care/service delivery, commercial and academic backgrounds. Thematic analysis helped to explore how different factors could facilitate/inhibit innovation at individual, organisational and wider societal levels.

Results We conducted 14 interviews and found that a conducive climate for healthcare innovation consisted of national/regional strategies stimulating commercial competition, promoting public/private relationships, and providing central direction (e.g. incentives for adoption and regulation through standards) without being restrictive. Organisational attitudes with a willingness to experiment and to take risks were also seen as important, but a bottom-up approach to innovation, based on the identification of clinical need, was seen as a crucial first step to construct relevant national policies.

Conclusions There is now a need to create mechanisms through which front-line National Health Service staff can raise ideas/concerns and suggest opportunities for improvement, and then build national innovation environments that seek to address these needs. This should be accompanied by creating competitive health technology markets to stimulate a commercial environment that attracts high-quality health information technology experts and innovators working in partnership with staff and patients.

Keywords: Innovation, healthcare, national strategy

BACKGROUND

Global societal challenges surrounding population growth and the associated threats to health and the sustainability of health care systems have put technological innovation high on many national policy agendas, resulting in international efforts to excel in this area.¹ Examples of countries that do particularly well in this respect include the United States (US), which is regarded as an international leader in healthcare innovation; Taiwan has made a global name in production innovation; and Germany is seen as a leader in developing professional innovation capacity (see Box 1).^{2–10} The United Kingdom (UK) is, however, lagging behind – of particular concern is that despite a number of initiatives to stimulate activity, overall innovation-related activity is declining.^{11,12}

There is also a lot to be learnt from other industries, where significant work is taking place in order to stay ahead of the competition.¹³ The retail sector, for example, has seen an enormous growth in personalising advertising and shopping experiences,¹⁴ and financial services have been transformed by online access and virtual forms of money.¹⁵ However, UK healthcare is struggling in relation to both technological innovation (many currently used tools are relatively antiquated when compared to the commercial sector) and related service transformation (new technologies are often seen as an unwelcome disruption to existing ways of working). Underlying reasons include the high level of regulation in the National Health Service (NHS), its centralised nature, sensitivity of health-related data, the variety of highly specialised and autonomous healthcare workers from different professions using new technologies and the generally high-risk environment of care provision.^{16–18} The imperative to promote innovation demands that these challenges are negotiated and, if necessary, overcome.¹⁹

There are potentially important lessons to be learnt from international settings, particularly those that have created local and national environments that enable innovation in healthcare to flourish. Existing empirical work has mainly focused on exploring innovation climates in organisational settings and specific teams,^{20–22} and we therefore aimed to identify what national strategies can help to promote a climate for innovation in healthcare settings through seeking potentially transferable lessons for the UK from international innovators.

METHODS

We conducted a qualitative study using semi-structured interviews with a range of innovators from international healthcare settings.

Ethical approval

This work received ethical approval from the Centre for Population Health Sciences at The University of Edinburgh, UK. All participants were fully aware of what participation entailed, were given the opportunity to ask questions beforehand, and gave written consent to participate. To ensure confidentiality of personal data, all participants were identified

using a number. All interview transcripts were anonymised and any potentially disclosing information relating to places or people was removed.

Recruitment of participants

We scoped the existing literature surrounding health information technology (HIT) and innovation, to develop a purposive sampling frame for recruiting participants.²³ This involved collating examples of innovations under the following broad headings: technological, social, organisational and national strategies (see Tables 1 and 2). For each of the example technologies identified, we searched the internet to find key senior contacts (e.g. head of company or senior academic). One contact was approached per exemplar technology, resulting in 38 invitations being sent. In doing so, we paid attention to sampling a range of participants from different backgrounds including technology, engineering, academia, policy, and clinical settings. We also approached participants from a range of international settings, although most respondents were from the US. Participants were approached via email to enquire if they were interested in participating, with a follow-up email sent two weeks later. Out of the 38 participants we approached, 19 responded and interviews were arranged with 14. The remainder either cancelled due to other commitments or did not reply to follow-up emails.

Data collection and handling

We conducted 14 telephone/Skype interviews with stakeholders. Interviews were structured around existing needs/experiences and features of the relevant stakeholder/technology, and around exploring which factors were perceived to facilitate/inhibit an innovation climate in healthcare (see Box 2 for the topic guide). Discussions were digitally audio-recorded and transcribed verbatim by a professional transcriber. The number of interviews was determined through the principle of thematic saturation – we stopped collecting new data when no major new themes were emerging in the concurrent analysis.²⁴ Findings were fed back to individual participants through sending a summary of the results, which resulted in minor modifications mainly in relation to adding clarification (e.g. surrounding US-centric concepts such as value-based care).

Data analysis

Qualitative data collection and analysis was iterative, allowing emerging themes to be examined further and disconfirming evidence to be sought.²⁵ Multiple perspectives allowed exploring views surrounding innovation from different angles and identifying where and how different data converged and diverged.²⁶

The transcripts were checked for accuracy by KC and uploaded onto NVivo10, a qualitative analysis software package.²⁷ Initial coding of data involved using the topic guide as a coding framework (the deductive component of the analysis), whilst also allowing emerging themes to develop (the inductive component).²⁵ All authors discussed the coding framework and coding was conducted by KC.

Box 1 International examples of innovation strategies**The Silicon Valley model – innovation ideas hub^{1,2}**

Biggest high-tech manufacturing centre in the US
 High concentration of commercial companies located in the area
 Stanford University links
 High venture capital investment
 Focus on generating innovation ideas
 Companies start small but with the constant aim to scale up
 Recruit the most talented people through innovative interviews (e.g. idea jamming sessions)
 Model of co-creation of products with customers
 Employees are actively engaged in business and innovative ideas help to thrive (boomerang passes, testing ideas, thinking outside the box)
 Cross-fertilisation with other industries and international experts

The Taiwanese model – focus on production innovation^{3–6}

Using globalisation to their advantage
 Focus on manufacturing activity
 Increasing patenting activity
 Increasing focus on contract manufacturing
 Many small and medium enterprises integrated with global production networks
 Close collaboration between firms
 Bringing together experts from different areas to work together
 Flexible production system (focus on making small parts that can be used for a variety of products)
 Global collaboration (production of products design elsewhere)
 Strong governmental support for innovation

German approach – increasing innovation capacity^{7–9}

Focus on driving innovations that ensure that productivity gains are broad rather than concentrated on small sectors or parts of the population (focus is not on new products but on enhancing existing ones)
 Established position of governmentally subsidised institutions that help companies move from idea to market on a large scale
 Constant high-quality training of the workforce (both practical and theoretical, resulting in highly specialised workers)
 Empowering workers
 Valuing engineers
 Improving productivity
 Large number of technology manufacturing firms
 Ranking high on research and development (R&D) intensity, manufacturing capability, high-tech density, and patent activity

1. <http://www.forbes.com/sites/kevinready/2015/11/10/japans-emerging-culture-of-innovation-the-invisible-things-can-be-the-hardest-to-change/>
2. <http://www.fastcodesign.com/3026220/tap-into-the-7-secrets-of-silicon-valleys-innovation-culture>
3. <https://hbr.org/2014/11/why-silicon-valley-shouldnt-be-the-model-for-innovation>
4. <http://www.cosmeticsdesign-asia.com/Market-Trends/Taiwan-and-South-Korea-named-as-Asia-s-innovation-leaders>
5. http://images.businessweek.com/bloomberg/pdfs/most_innovative_countries_2014_011714.pdf
6. Lee, P. C., & Su, H. N. (2015, August). Evolution of science, technology and innovation policy in Asia: Case of China, South Korea, Japan and Taiwan. In Management of Engineering and Technology (PICMET), 2015 Portland International Conference on (pp. 184-191). IEEE.
7. <https://hbr.org/2014/05/why-germany-dominates-the-u-s-in-innovation/>
8. http://images.businessweek.com/bloomberg/pdfs/most_innovative_countries_2014_011714.pdf
9. Bartelsman, E., Dobbelaere, S., & Peters, B. (2014). Allocation of human capital and innovation at the frontier: Firm-level evidence on Germany and the Netherlands. *Industrial and Corporate Change*, dtu038.

Table 1 Indicative sampling frame of technological innovation in healthcare and potential exemplar areas

Innovation	Exemplar area
Technological	Robotics Artificial intelligence 3D printing Cloud technology Holographic images
Social	Patient facing digital technologies Citizen-driven health Diagnostics and procedures Innovation in work practices and interdisciplinary working
Organisational	Workforce development Process innovation: innovation in service delivery Process innovation: innovation in business process management
National strategy	Integration of health and social care Learning health systems Public health: interdisciplinary skills, data analytics Partnerships: healthcare, research, commercial Big data: analytics, research, linked data, methods, tools and standards

Box 2 Sample topic guide

Views on innovation in healthcare (think both product and process innovation)

- What are currently the most promising developments in HIT innovation?
- What are the benefits associated with these?

Vision surrounding technological innovation in healthcare

- Fast forward 10 years – how should healthcare look like?
- What will help us achieve this?

Experiences of technological innovation in healthcare

- How are healthcare organisations deciding on which innovations to pursue?
- How does healthcare differ from other sectors?
- Which factors hinder developments and how might these be addressed?

Accelerating innovation in healthcare

- What can different stakeholders do to promote innovation in healthcare?
- How can policies help to accelerate HIT innovation?
- What can organisations do to accelerate HIT innovation?

Anything else?

RESULTS

Interviewees identified a range of aspects that were perceived to characterise a climate for innovation in healthcare settings (see Box 3). These ranged from health system factors, over organisational factors in healthcare and commercial organisations, to individual-level factors.

Box 3 Overview of themes**National strategies and regulatory environments**

Free markets stimulating innovation
Incentives to facilitate short-, medium-, and longer-term innovative activity
National guidance and regulation without stifling innovation

Cross-sectorial collaboration and organisational attitudes

Public/private collaboration
Organisational attitudes: risk-taking and willingness to experiment

Ensuring that innovation in healthcare is needs-based

Development of technology should be needs-driven
Work practices of healthcare professionals, human interaction and patient needs
Maturity of solutions and associated policies

National strategies and regulatory environments*Governmental approaches to stimulate innovation: free markets*

US-based interviewees argued that it was the nature of the free market in healthcare and the resulting competition that stimulated innovation in healthcare settings in their country. Competition between healthcare providers, it was argued, meant that patients ‘shopped around’, and in order to stay competitive, significant investments in innovation had to be made, which contributed to industry innovators being attracted to the healthcare sector.

I think what creates a climate is the fact that so much of healthcare is really controlled by sort of the market place...I think the fact that there's so much investment in healthcare that it's really developing within the free market economy is sort of leading innovators and entrepreneurs into that space. (Participant 13, Academic/Clinician)

Conversely, the publicly funded nature of the NHS, the relatively low per capita spending on healthcare and the relatively small size meant that innovative activities were restricted by a lack of funding and limited organisational motivation to operate as commercial enterprises. This, in turn, deterred innovators from being attracted to the sector.

Table 2 Participant characteristics

Participant number	Area	Background	Country	Gender
Participant 1	Smart technology	Technologist	USA	M
Participant 2	Anonymisation technology	Technologist	Netherlands	M
Participant 3	Human factors	Academic	USA	F
Participant 4	Epidemiology	Clinical informatics	USA	M
Participant 5	Policy	Health IT strategy	USA	M
Participant 6	Data analytics	Academic	USA	F
Participant 7	Patient-generated data	Technologist/Engineer	Spain	M
Participant 8	Natural language processing	Technologist/Engineer	UK	M
Participant 9	Open source	Policy/Technologist	USA	F
Participant 10	Virtual reality	Engineering	USA	M
Participant 11	Innovation center	Clinical	USA	M
Participant 12	Population health management	Analytics	USA	F
Participant 13	Primary care	Academic/Clinician	USA	M
Participant 14	Smart cities	Business Innovation	USA	M

I think what makes corporate America world class is their logistics because everything is a negotiation here. Now some of that will not fit in a cultural way with what is happening in [UK] but there's certainly opportunities to have those conversations where we may come up with some ideas that might be suitable... (Participant 14, Business Innovation)

Governmental approaches to stimulate innovation: incentives to facilitate short-, medium-, and longer-term innovative activity

Incentives were seen as an important way to stimulate competition amongst healthcare providers. For example, the stimulus package associated with the US Health Information

Technology for Economic and Clinical Health Act²⁸ was seen to have attracted innovators and as helping to focus organisational efforts on technological innovation.

I'm amazed the 40 billion dollars triggered a trillion more software investment from the healthcare system in the US and so it really, the stimulus worked much better than even I predicted. (Participant 11, Clinician)

However, interviewees cautioned that although the financial incentives stimulated investments in technological innovation, there was also a risk that new technologies were adopted in order to obtain payments as opposed to improve care. Longer-term innovative activity was therefore not viewed to be positively affected by financial incentives, as

these only had a short-term effects relating to initial investment in acquiring new technology. In contrast, participants suggested that the recent shift in the US towards value/outcome-based care (as opposed to service-based care) was an important step towards facilitating a longer-term innovation climate.

...most of [providers] do it the big bang theory...they get the incentive for the first year and then the second year they don't and it's like 'OK let's find another programme then'. So what has happened is programme chasing. (Participant 12, Analytics)

National guidance and regulation without stifling innovation

Political strategy and guidance was viewed as important to ensure interoperability and coordinated efforts, but interviewees highlighted that although crucial, nationally set certification standards (such as those in the US Meaningful Use Criteria) should not be too restrictive as this could stifle innovation. One suggested way to achieve this balance was setting general objectives nationally (e.g. implementing electronic health record technology), whilst still allowing flexibility and creative space to innovate (e.g. through choice of technology and interfaces).

To support innovation sometimes it's better to sort of just lay out the rules of the road but let [providers] figure out what they need to take from that. (Participant 6, Academic)

Similarly, the regulatory environment in the healthcare sector was seen by most innovators as inhibiting innovative activity. Privacy and security directives were often mentioned in the context of digital data, as they were seen to hinder sharing and collaboration between sectors (as data could not move freely). This was seen to be particularly true for Europe, where such regulations (e.g. the Data Protection Act) prohibited speedy experimental development of new technologies.

One of the things why in the States they are more advanced than here in Europe is about privacy...here we are very, blocking those innovations...in the States first they test and then they do all the privacy. It doesn't mean that they don't have privacy, it means that they have it a step later when they test the technology, so this really helps to speed up things. (Participant 7, Technologist/Engineer)

Licensing laws were mentioned in the context of devices, where lengthy evaluation periods often meant that functionalities were lacking flexibility and jeopardised market relevance. Participants therefore called for more flexibility and regulations tailored to functionalities of different devices.

Yeah so healthcare actually is very slow I think because of the regulatory environment primarily. The intense

focus on everything being over-analysed by a regulatory body. (Participant 1, Technologist)

Cross-sectorial collaboration and provider attitudes

Public/private collaboration

Participants discussed many factors that influenced organisational innovation climates, comparing between healthcare and other industries, and also between US and UK settings. Overall, collaboration between public and private entities (including providers, policy, industry, patients, academia and insurers) was argued to be key to successful approaches to innovation.

...the more we make [innovation] siloed, the less there is innovation. (Participant 12, Analytics)

This collaborative model should comprise concerted efforts to streamline investments across providers and developing incubator communities involving different stakeholder groups with the common motivation to innovate. Experiences from successful health system initiatives and other industries were used to illustrate how this had been achieved through discussion and alignment of different interests and needs, followed by identification of potential technological solutions that fulfilled these.

You can think of it as putting all the interests in one pot and then saying what are the solutions that can potentially optimise a successful achievement of the collection of all interests together and then can the different stakeholders live with that. (Participant 5, Policy)

Commercial, academic and provider relationships were seen as particularly important, and were often promoted by individuals who could span boundaries across these sectors. Here, participants gave examples of technologists with clinical backgrounds (helping to design technologies that were needs-based) or academics who worked in commercial settings (helping to stay abreast of innovative developments).

We cannot have like old time professors that never work in a company or they do some partial work there because...they are super out of the world... in the States it's a bit different [to Europe] because most of the professors work in the real world. (Participant 7, Technologist/Engineer)

Different examples from the US to promote collaboration included partnering small businesses with universities, co-innovation through collaboration between commercial competitors, giving seed money to small businesses, regional venture programs, and pooling of resources. Technology hubs and incubator communities were viewed as particularly important in this context as they allowed individuals from different backgrounds to get together deliberate issues of common interest and exchange ideas.

... to get the right people in the same room to be able to look at the same problem and each group brings their own perspective. And the same kind of thinking that makes a problem isn't the same kind of thinking that will solve the problem...there's a reason why there are hubs of things, there are technology hubs meaning that people with a similar slant on things congregate and share ideas. (Participant 3, Academic)

Provider attitudes: risk taking and willingness to experiment

Many participants argued that an organisational willingness to embrace and stimulate change, to experiment and provide a risk taking environment was key to innovation, but healthcare organisations – particularly in the UK where funding was tight and immediate care-related activities took priority – were seen to be relatively risk-averse. As a result, there was a lack of local investment in innovation-related activities.

The environment must be willing to take risks and willing to allow the sharing of thoughts, communication, data and the willingness to mess up sometimes and the willingness to identify good ideas and push them forward. (Participant 3, Academic)

This was seen to be exacerbated by a lack of innovative mind-sets amongst clinicians, a lack of designated time away from providing patient care to engage in such activity, limited managerial efforts to promote creative thinking, and a lack of collaborative working between informatics staff (which are scarce in the UK) and clinical users. Experiences from organisations that were perceived as innovative included providing a 'safe space' for innovators, who were given the licence to engage in blue-sky thinking.

The most innovative organisations bring together the most bold thinkers and give them licence to be creative...the licence to think in unusual and unique ways and giving them an incubator to go off and build it [the technology]...giving them that empowerment you have to change the culture in supporting that environment of innovative thinking. (Participant 9, Policy/Technologist)

Ensuring that needs of patients and healthcare professionals are addressed

Development of technology should be needs-driven

Despite the range of environmental and organisational factors that played a role in promoting and/or inhibiting innovation climate, interviewees also cautioned that innovations had to be needs-based to be successfully adopted. Increasingly high levels of development activity associated with new technologies, their surrounding hype and the promise of 'big money' for some stakeholders were in some respect seen to jeopardise this. In addition, the focus on promoting innovative activity was seen to create a host of technological solutions

within the healthcare field that did not necessarily emerge from existing health system needs. In other instances, technological solutions were seen to be introduced to problems that did not necessarily require technological intervention.

...everybody is now looking for the next crazy app that will disrupt anything and makes them rich or something. But it's not so much about the technology, it's more about...finding the right solution that really serves the whole system... (Participant 4, Clinical Informatics)

Work practices of healthcare professionals, human interaction and patient needs

Existing needs included those of local healthcare organisations, who were perceived to select which innovations to pursue based on the characteristics of their local populations and current national targets, and also the needs of clinicians within those organisations. Here, the disruptive nature of some technological systems to clinical work practices was mentioned by many, as was the potentially adverse impact of new technologies on the personal aspect of delivering care.

...you have to tell me why this is going to help me to take care of my patient better, faster and more consistently. If you can't do that, then the technology means absolutely nothing...(Participant 9, Policy/Technologist)

Maturity of solutions and associated policies

Participants further referred to potentially adverse consequences for the safety and quality of care that could result from the adoption of immature technologies. There was a perceived risk amongst some that strategic directions may, in attempting to promote innovation nationally and locally, deploy technologies prematurely and/or implement them without understanding local practices and needs. Thorough evaluation of new technologies before they were deployed in healthcare environments was therefore viewed as crucial for their safe and effective use and in ensuring that innovative technologies were empowering, as opposed to undermining policies.

It's important to support innovation, but also to require maturity of the solutions before they're broadly adopted...especially the more political the decision making becomes, the more government policies tend to adopt the next bright shiny object. (Participant 5, Policy)

DISCUSSION

This study indicates that healthcare innovation should be a strategic imperative at national level, ensuring that technological developments address an established clinical need rather than presenting a reactionary response to market trends. Both public and private sector input and meaningful incentives need to be in place, while recognising the need for both competition and collaboration.

Our analysis has provided insights into how national, organisational, and individual factors can contribute to creating a climate for technological innovation in healthcare settings. Existing empirical work has, to date, mainly focused on exploring organisational climates, somewhat neglecting the wider network of stakeholders that need to be involved at organisational and national levels. Previously, a risk-taking climate and appropriate allocation of resources have been identified as organisational factors associated with innovativeness.²⁹ Our work builds on these findings, by painting a more nuanced picture of the wider innovation landscape, where cross-organisational public/private collaboration needs to be combined with national direction to coordinate efforts and stimulate competition without stifling innovation. Regulation can in this context play both an inhibiting role (as mentioned by our sample) and a facilitating one.³⁰ The central direction should involve attracting a range of commercial suppliers and preventing the emergence of a monopoly. The limited number of commercial vendors has become a real threat to a vibrant commercial market in UK HIT since the end of the National Programme for Information Technology in England.³¹

Interviewees have provided important insights surrounding potential ways to stimulate an innovation climate in the UK. However, findings relate to a relatively limited number of participants mainly from US-based settings and with expertise in a limited range of technological applications. It maybe that saturation was reached partly because of the general level of the discussion and limited contexts. It is also important to keep in mind that participants were positioned within a certain sociopolitical context that may have influenced their responses and may limit generalisability of findings to the UK. For example, there was an uncritical acceptance by many that technological innovation was inherently 'good' reflecting wider socioeconomic discourses surrounding the US' position as an international economic leader. Similarly, there are some cultural differences surrounding professional identity that may have impacted on how participants from different sociopolitical backgrounds viewed innovation. Many had an interest in innovation to flourish as this was a crucial aspect of their occupation. We further lacked input from a patient perspective, which could have added another dimension surrounding 'user/patient-pull' towards stimulating innovative activity in particular areas of need. We now plan to explore these initial findings in more depth through detailed case studies of the most promising technologies identified by participants. These included: 1) patient-/person-generated data and its integration into electronic health records, 2) innovative information infrastructures (e.g. smart facilities and cloud-computing), 3) robotics, and 4) novel analytical strategies to make better use of existing data.

Ongoing efforts should emerge from and align with local needs of technology users. The NHS has almost 1.7

million frontline and backend staff – making it the fifth biggest employer in the world – who could help to identify these needs and opportunities, but no large scale efforts to do so have to date been made.^{32,33} This is therefore an essential next step that needs to be taken through for example creating national innovation centres that promote conception, development and testing of innovations, and by working in partnership with frontline healthcare staff and patients.^{34,35}

Existing conceptual models of the policy process have recognised this need to begin with a definition of a problem and then strategically plan policies based on this, but these processes are rarely followed in the real world.^{36–38} Especially in healthcare policies, this needs-based model is not always followed, perhaps because organisational and user needs vary so significantly, and the political context where there is still substantial debate about the optimal degree of involvement of national governments in healthcare policy.³⁹

Effective public/private alliances were found to result in access to a range of resources/insights that were otherwise untapped, with healthcare organisations offering insights into opportunities for technological innovation based on organisational/individual need, and industry providing access to technological solutions (what Dyer and Singh call 'complementary capabilities').⁴⁰ Hence, the widely advocated focus on creating innovation centres seems appropriate, although some barriers to their success have been identified including shortage of funding, lack of integration with clinical settings, and sub-optimal sharing mechanisms.^{19,41} Our analysis suggested that for these actors to contribute to a wider innovation climate, competition is necessary to stimulate activity.

Although a number of initiatives in the UK exist to promote healthcare innovation (see Box 4),^{42–47} there is still a lot of room for improvement. Achieving a balance between central coordination of innovative activity to spread knowledge and stimulate competition, and local collaboration to identify needs and build solutions based on these, should be a defining characteristic of national health policy. Such efforts should be characterised by creating safe spaces for collaborative endeavours, devising incentives to promote innovative activity, creating innovative funding models, and building a climate where experimentation and potential associated 'failure' is encouraged rather than shied away from. There may also be scope to follow a flexible approach to healthcare innovation policy that leverages relationships with academia, non-profit organisations and private sector organisations to help develop a roadmap for innovation strategies in the UK. This should be revisited regularly for public comment. Such an approach is already successfully employed in the US,⁴⁸ and could help to ensure that public policy and government regulations and associated adoption of new healthcare innovation efforts is sustainable for the healthcare delivery community at large.

Box 4 Current national initiatives in the UK to promote healthcare innovation

Patent box legislation: reduces tax paid by commercial companies on profits made through patents

Small business research initiative: supports small- and medium-sized enterprises (SMEs) in creating and commercialising innovative ideas that address public sector issues, including healthcare

Innovation vouchers programme: vouchers available to SMEs designed to pay for expert input e.g. from universities

Launchpads scheme: central funding to run R&D projects for SMEs to develop new products or services

British Business Bank: an economic development bank with the aim to provide good credit conditions and strategic/financial advice to SMEs

Catapult centres: centres of excellence that connect academic and commercial partners and provide funding to promote innovation

R&D expenditure credit (RDEC) scheme: providing tax credits for SMEs

R&D allowance: tax breaks for money spent on R&D

New legislation on copyright streamlining intellectual property applications

Centralised funding for universities encouraging partnerships with SMEs

Increasing investment in system evaluations

International Education Council: promotes the relationship between higher education and research (with the aim to retain talent)

UK Trade and Investment: promoting links between SMEs and global funding opportunities

Silver Public Procurement to promote public–private partnerships

CONCLUSIONS

We have identified factors associated with creating a climate for healthcare innovation by consulting a range of innovators from high performing international health systems. In attempting to identify potentially transferable lessons for UK healthcare, we found that health system level factors are important in stimulating innovation through creating incentives and promoting competition, whilst public/private partnerships can help to find novel solutions to existing problems. Individual users of technologies play an important part throughout this process, as developed systems and associated policies should address an established need, ensuring that new technologies provide solutions to challenges faced by health systems and do not become a new threat. Providers should now be consulted to identify ‘pain points’ that healthcare innovation can and needs to address.

Overall, it is important to keep in mind that even the most innovative organisations at times doubt strategic directions and revert back to old habits. However, they seem to have an inherent drive to move forward. This drive should be harnessed, championed by healthcare pioneers that learn and share lessons globally to address healthcare’s increasing challenges.

Competing interests

All authors declare that they have no competing interests.

Funding

KC is supported by a Chief Scientist Office of the Scottish Government Post-doctoral Fellowship and AS is supported by the Farr Institute.

Acknowledgements

We gratefully acknowledge the input of all participants who gave their time and Rosemary Porteous, who transcribed the interviews.

REFERENCES

1. Innovation policy, national innovation systems and economic performance: in search of a useful theoretical framework. Available from: http://www.sv.uio.no/tik/InnoWP/tik_working_paper_20150321.pdf. Accessed 15 May 2016.
2. Japan’s emerging culture of innovation: the invisible things can be the hardest to change. Available from: <http://www.forbes.com/sites/kevinready/2015/11/10/japans-emerging-culture-of-innovation-the-invisible-things-can-be-the-hardest-to-change/#7e1e0d5d6ae9>. Accessed 15 May 2016.
3. Tap into the 7 secrets of silicon valley’s innovation culture. Available from: <http://www.fastcodesign.com/3026220/tap-into-the-7-secrets-of-silicon-valleys-innovation-culture>. Accessed 15 May 2016.
4. Why silicon valley shouldn’t be the model for innovation. Available from: <https://hbr.org/2014/11/why-silicon-valley-shouldnt-be-the-model-for-innovation>. Accessed 15 May 2016.
5. Taiwan and South Korea named as Asia’s innovation leaders. Available from: <http://www.cosmeticsdesign-asia.com/Market-Trends/Taiwan-and-South-Korea-named-as-Asia-s-innovation-leaders>. Accessed 15 May 2016.
6. These are the world’s most innovative economies. Available from: <http://www.bloomberg.com/news/articles/2016-01-19/these-are-the-world-s-most-innovative-economies>. Accessed 15 May 2016.
7. Lee PC and Su HN. Evolution of science, technology and innovation policy in Asia: case of China, South Korea, Japan and Taiwan. 2015 Portland International Conference on Management of Engineering and Technology (PICMET), IEEE, 2015, pp. 184–191.
8. Why Germany Dominates the U.S. in Innovation. Available from: <https://hbr.org/2014/05/why-germany-dominates-the-u-s-in-innovation/>. Accessed: 15 May 2016.

9. The Bloomberg Innovation Index. Available from: <http://www.bloomberg.com/graphics/2015-innovative-countries/>. Accessed 15 May 2016.
10. Bartelsman E, Dobbelaere S and Peters B. Allocation of human capital and innovation at the frontier: Firm-level evidence on Germany and the Netherlands. *Industrial and Corporate Change* 2014;24 (5):875–949.
11. Available from: <http://www.theguardian.com/technology/2014/nov/05/hermann-hauser-science-catapults-more-innovation-uk>. Accessed 15 May 2016.
12. Science, technology and innovation. Available from: <http://www.gov.scot/Topics/Business-Industry/science>. Accessed 15 May 2016.
13. A vision for using digital health technologies to empower consumers and transform the U.S. health care system. Available from: <http://www.commonwealthfund.org/publications/fund-reports/2014/oct/vision-digital-health-tech>. Accessed 15 May 2016.
14. In-store retail innovation 2016: five industry predictions. Available from: http://www.huffingtonpost.com/josh-marti/instore-retail-innovation_b_8761350.html. Accessed 15 May 2016.
15. Four technologies that will revolutionize financial services. Available from: <http://bankinnovation.net/2014/04/four-technologies-that-will-revolutionize-financial-services/>. Accessed 15 May 2016.
16. Hudson P. Applying the lessons of high risk industries to health care. *Quality and Safety in Health Care* 2003;12(suppl 1):i7–12.
17. Gaba DM. Structural and organizational issues in patient safety: a comparison of health care to other high-hazard industries. *California Management Review* 2000;43(1):83–102. <https://doi.org/10.2307/41166067>
18. Christensen CM, Bohmer R and Kenagy J. Will disruptive innovations cure health care? *Harvard Business Review* 2000;78(5):102–12.
19. Why Do We Need Innovation in Health Care? Available from: <http://www.commonwealthfund.org/interactives-and-data/infographics/2015/apr/innovation-in-health-care>. Accessed 15 May 2016.
20. Lämsäalmi H, Kivimäki M, Aalto P and Ruoraniemi R. Innovation in healthcare: a systematic review of recent research. *Nursing Science Quarterly* 2006;19(1):66–72. <https://doi.org/10.1177/0894318405284129>
21. Burningham C and West MA. Individual, climate, and group interaction processes as predictors of work team innovation. *Small Group Research* 1995;26(1):106–17. <https://doi.org/10.1177/1046496495261006>
22. Somech A and Drach-Zahavy A. Translating team creativity to innovation implementation the role of team composition and climate for innovation. *Journal of Management* 2013;39(3):684–708. <https://doi.org/10.1177/0149206310394187>
23. Ritchie J, Lewis J, Nicholls CM and Ormston R, ed. *Qualitative Research Practice: A Guide for Social Science Students and Researchers*. New York: Sage, 2013.
24. Guest G, Bunce A and Johnson L. How many interviews are enough? An experiment with data saturation and variability. *Field Methods* 2006;18(1):59–82. <https://doi.org/10.1177/1525822X05279903>
25. Pope C, Ziebland S and Mays N. Analysing qualitative data. *BMJ* 2000;320(7227):114–6. <https://doi.org/10.1136/bmj.320.7227.114>. PMID:10625273; PMCID:PMC1117368.
26. Seale C. Quality in qualitative research. *Qualitative Inquiry* 1999;5(4):465–78. <https://doi.org/10.1177/107780049900500402>
27. QSR International. NVivo 10 for Windows. Available from: http://www.qsrinternational.com/products_nvivo.aspx. Accessed September 4 2016.
28. Blumenthal D. Launching HITECH. *New England Journal of Medicine* 2010;362(5):382–5. <https://doi.org/10.1056/NEJMp0912825>. PMID:20042745.
29. Nystrom PC, Ramamurthy K and Wilson AL. Organizational context, climate and innovativeness: adoption of imaging technology. *Journal of Engineering and Technology Management* 2002;19(3):221–47. [https://doi.org/10.1016/S0923-4748\(02\)00019-X](https://doi.org/10.1016/S0923-4748(02)00019-X)
30. Munos B. Lessons from 60 years of pharmaceutical innovation. *Nature Reviews Drug Discovery* 2009;8(12):959–68. <https://doi.org/10.1038/nrd2961>. PMID:19949401.
31. Sheikh A, Cornford T, Barber N, Avery A, Takian A, Lichtner V et al. Implementation and adoption of nationwide electronic health records in secondary care in England: final qualitative results from prospective national evaluation in ‘early adopter’ hospitals. *BMJ* 2011;343:d6054.
32. Key statistics on the NHS. Available from: <http://www.nhsconfed.org/resources/key-statistics-on-the-nhs>. Accessed May 15 2016.
33. Which is the world's biggest employer? Available from: <http://www.bbc.com/news/magazine-17429786>. Accessed May 15 2016.
34. Kaiser Permanente Policy Story. Available from: <http://www.kpihp.org/kaiser-permanente-policy-story-v3-no-4-innovation-at-kaiser-permanente/#sthash.Es4i72es.dpbs> Accessed May 15 2016.
35. Garfield Innovation Center. Available from: <https://xnet.kp.org/innovationcenter/index.html>. Accessed May 15 2016.
36. Bardach E. *Practical Guide for Policy Analysis: the Eightfold Path to More Effective Problem Solving*. New York: Sage, 2011.
37. Knaggård Å. What do policy-makers do with scientific uncertainty? The incremental character of Swedish climate change policy-making. *Policy Studies* 2014;35(1):22–39. <https://doi.org/10.1080/01442872.2013.804175>
38. Etzioni A. Mixed-scanning: a ‘third’ approach to decision-making. *Public Administration Review* 1967;27(5):385–392. <https://doi.org/10.2307/973394>
39. Cresswell K, Bates D and Sheikh A. Five way for national governments to get value from HIT. *Lancet* (in press). <https://doi.org/10.2307/259056>
40. Dyer JH and Singh H. The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review* 1998;23(4):660–79. <https://doi.org/10.5465/AMR.1998.1255632>
41. Taking Digital Health to the Next Level. Available from: <http://www.commonwealthfund.org/~media/files/publications/>

fund-report/2014/oct/1777_hostetter_taking_digital_hlt_next_level_v2.pdf?la=en. Accessed May 15 2016.

42. Why the UK always falls short in global innovation rankings. <http://www.cityam.com/228660/why-the-uk-always-falls-short-in-global-innovation-rankings>. Accessed May 15 2016.
43. Small Business Research Initiative. Available from: <https://sbri.innovateuk.org/>. Accessed May 15 2016.
44. Innovation Vouchers. Available from: <https://vouchers.innovateuk.org/home>. Accessed May 15 2016.
45. Innovation: get details about Innovate UK funding competitions. Available from: <https://www.gov.uk/guidance/innovation-get-details-about-innovate-uk-funding-competitions>. Accessed May 15 2016.
46. United Kingdom STI Outlook 2014. Available from: <https://www.innovationpolicyplatform.org/content/united-kingdom>. Accessed May 15 2016.
47. OECD Science, Technology and Industry Outlook 2014. Available from: http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/oecd-science-technology-and-industry-outlook-2014_sti_outlook-2014-en#page1. Accessed May 15 2016.
48. The Office of the National Coordinator for Health Information Technology. Connecting Health and Care for the Nation: A 10-Year Vision to Achieve an Interoperable Health IT Infrastructure. Washington, DC: HHS. Available from: <https://www.healthit.gov/sites/default/files/nationwide-interoperability-roadmap-draft-version-1.0.pdf>. Accessed May 15 2016.