How do new technologies impact on workforce organisation?

Rapid review of international evidence
Report developed by The Evidence Centre for Skills for Health

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Contents

Key Themes

Scope

New technologies are introduced frequently in healthcare. This review examines how the introduction of new technologies changes the way healthcare staff and teams are organised and describes the process by which staff adopt new technologies. The focus is not on specific types of technology, but rather how introducing new tools changes how the workforce is put together to deliver services.

To identify studies for inclusion in the review, one reviewer searched six bibliographic databases for empirical research available as of February 2011. More than 15,000 abstracts were screened and 302 were eligible for inclusion in the review.

Staff organisation

The review found that new technologies mean that less qualified or experienced staff can successfully provide diagnosis and care than might previously have been the preserve of higher grades. Examples are particularly evident in radiology, critical care and A&E.

Communication and information technologies allow teams to be drawn from different organisations and disciplines, meaning that more inter-professional collaboration and learning is possible. Such technologies also allow teams to provide care remotely for patients, across geographic regions. This may reduce travelling time for staff and patients, thereby increasing capacity, centralisation and productivity.

Technological advances mean that patients can also take more responsibility for care and become an integral part of the care team.

There is little evidence about whether introducing new technologies increases or reduces working hours or impacts on teams in other practical ways. Case studies about certain technologies are available but this does not translate into generalisable trends. This is largely because the impact of new technologies depends on the organisational and team context.

Implementation influences

There is no standard lifecycle by which new technologies are adopted by healthcare teams because there are significant variations between teams, organisations and countries. The 'innovation cycle' suggests that the roll out of new technologies tends to follow the process of discovery, adoption, diffusion and routinisation, however innovation rarely corresponds to a linear model and these stages may sometimes happen simultaneously.

There is informal evidence that consultants and senior grade staff may have access to new technologies before allowing roll out to more junior staff once the technologies have been tested and their capabilities understood. However this is not always the case, and technologies designed to support administrative or junior functions tend to be tested immediately by the staff involved.

Research in the UK suggests that healthcare staff are not using new technologies to the fullest extent. Focusing on the perceived advantages of new technologies, patient need, values held by staff peers and leaders, and communication mechanisms facilitates adoption of new technologies by healthcare

Roll out mandated by centralised or managerial sources may be slower than that built upon a social movement approach, local champions or informal social structures, however there is limited empirical evidence about the average time it takes to adopt and diffuse technological innovations in different contexts.

Impacts of technology

New technical, information and communication technologies and the workforce changes associated with them can support and drive innovative work practice, improve care processes, and impact on efficiency and productivity. There are also positive impacts as well as challenges for staff, including the need for enhanced training.

Introducing new technologies does not guarantee positive outcomes. Simultaneous developments in leadership, financial resources, personal and organisational relationships, engagement with patients and families, care coordination and staff development are needed. There is also a need to consider how the workforce needs to develop to gain most potential from new technologies. The most important question to address may not be how are staff currently being reorganised in the wake of new technologies, but rather how should staff best be deployed to take full advantage of the potential available.

Scope

Health services are constantly changing in order to adapt to population demographics, the prevalence of long term conditions, advances in technology and medicines and changes in the workforce. Policy makers, practitioners and planners all acknowledge that technology continues to change at lightning speed and that this impacts on the way healthcare is staffed and organised.[1,2]

This review summarises key learning from the UK and around the world regarding how new technologies are influencing or changing how people and teams are organised and how such technologies are commonly adopted and rolled out by healthcare services.

The core questions addressed are:

How are people and teams being organised around the use of new, or recently introduced, technologies?

What is the typical life cycle of staff engagement with a new technology when it is first introduced?

What is the impact on services, patients and practitioners of different skill mix and service delivery solutions?

Judgements about the extent of 'newness' of technologies depend on the context. A technology that may seem new in one environment may have been implemented successfully for many years in another. The review takes a pragmatic approach when defining new technologies and focuses on innovations that have been introduced for routine use in health services within the past decade or so and are deemed 'new' by the research publications collated. Specific technologies are not the focus of the review, but examples of technologies that have been introduced reasonably recently include health information technologies, telemedicine, new screening and diagnostic technologies, and new communication approaches such as handheld computers and PDAs.[3]

Approach

To identify studies for inclusion in the review, one reviewer searched six electronic databases (Medline, Embase, Ovid, Cinahl, the Cochrane Library and Controlled Trials Register, and the Health Management Information Consortium) for articles published between 1990 and February 2011. Search terms included combinations of words such as technology, telemedicine, staffing, workforce, adaptation, implementation, lifecycle, impact, staff engagement and so on.

As the aim was to provide a rapid review of key themes in readily accessible literature, studies of any design, in any language and from any country were eligible for inclusion. Empirical research was prioritised, including systematic reviews, randomised controlled trials and large observational studies.

The search identified more than 15,000 potentially relevant studies, but after further review most were found not to address the core research questions empirically. 302 references were included in the review.

All studies were checked for relevance by one reviewer, using the methodology of the NHS Centre for Reviews and Dissemination. Two reviewers independently extracted bibliographic data and information about key findings.

To synthesise material, the reviewers grouped studies according to topic areas and outcomes and provided a narrative summary of key trends. Meta-analysis was not possible due to the heterogeneity of the study designs and technologies covered.

The reviewers aimed to provide a mix of rapidity and rigour, but when interpreting the review, readers should bear in mind:

The review focused on readily available literature and was completed within a short period. It is not a systematic appraisal of all material in this field.

There are many studies about introducing new technologies but these do not usually consider the impacts on staff and team organisation so these general studies were excluded from the review.

The quality of literature varied. Much of the material is descriptive or observational and not necessarily of high quality.

Omission of specific types of technologies within the review does not indicate that they do have important impacts on workforce organisation, just that little has been published about some topics.

Many studies are from the US, Canada or other countries with very different health systems to the UK. This means that the findings may not be generalisable to the UK context.
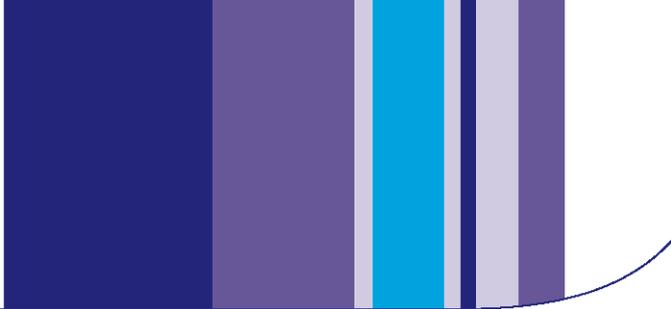
How are teams being organised?

Substituting grades and roles

New technologies are being implemented in healthcare at an increasing rate.4 The introduction of new technologies impacts on how the workforce is organised. Published evidence from around the world suggests that regardless of the type of technologies introduced, the key impacts on how staff and teams are organised are similar. This section describes some of the key impacts including the substitution of staff roles, patients as members of the care team, changes to where work can be undertaken, working across organisational boundaries and working across geographic boundaries.

Sometimes different grades of staff can be used to undertake tasks following the introduction of new technologies.5 Senior people may no longer be required if technologies can simplify certain tasks. In the same vein, this may mean that nurses can undertake roles that were once the preserve of doctors or healthcare assistants can undertake tasks previously completed by nurses.

For instance, researchers in the US examined the effects of using an automated prescription filling system in an independent pharmacy. Videotapes and work sampling techniques before and after implementation were used to compare how pharmacy staff spent time in prescription filling activities such as receiving, order entry, filling, inspecting, packaging, dispensing, phone calls and inventory management. Automation saved staff time but required staffing adjustments to optimise the efficiency gained such as using senior staff for checking and gradually deploying more junior staff over time.6

'Task shifting' involves delegating tasks to existing or new cadres with either less training or narrowly tailored training. Task shifting has been used to address workforce shortages and skill mix imbalances, and may be made possible through the introduction of new technologies.7 As an example, the advent of new breast screening technologies means that assistant practitioners can now undertake screening, freeing up the time of more senior staff for other patient care.

A great many descriptions and theoretical articles about task shifting and skill and role substitution are available but there are few empirical studies exploring the impacts on staffing in any depth.

One example comes from Australia, where some radiographic examinations are performed by remote nurses and GPs when a radiographer is unavailable. This is known as remote x-ray operator radiography. Researchers found that practitioners perceive this to increase access to

services, but the quality of x-rays was thought to be lower than if they were performed by a specialist. The authors suggest that better teamwork could improve the quality of services but interprofessional collaboration was stifled by hierarchical relationships.[8]

A number of other studies have found that technology allows lower grade staff to be used to good effect within the field of radiology.[9,10] For example, in the US, centres have tested using physician assistants to interpret x-rays, consult with referring specialists and perform less complicated interventional procedures. Small scale studies suggest that deploying support staff in this way may enhance efficiency and productivity.[11,12] Other examples are available in the field of sonography, where 'ultrasound practitioners' substituted for some tasks traditionally undertaken by radiologists.[13]

But there are limits in the information available and queries about quality of care. For example, new technologies mean that laser procedures can be performed by non specialists. However surveys in the US suggest that dermatologists may be critical about the use of new clinical laser procedures by non doctors.[14]

A systematic review described a range of extended practice roles for allied health professionals but found that there is little evidence about how best to introduce such roles, or how best to educate, support and mentor these practitioners. Health outcomes for patients have also rarely been evaluated.[15]

A small number of studies are available about the development of completely new roles as a result of new technologies. For instance in the US, Regional Health Information Organisations (RHIOs) have been developed to increase the efficiency of information technology in the healthcare sector. Patients may move across regions and these regional organisations can share data across geographic boundaries. As well as information technology roles, such organisations also require clinicians or new joint roles with staff combining technical and clinical skills.[16]

Such new roles combining clinical and technological expertise are increasing.

"There is a role in healthcare organisations for interdisciplinary workers who understand clinical medicine, healthcare management, information technology, and who can communicate and work effectively across these organisational boundaries."[17]

Reducing staff or team size

Using new technologies may cut down the number of staff needed to perform tasks, thus freeing up capacity to use skilled staff elsewhere. For instance, in Austria robotic camera holders were used to make laparoscopic cholecystectomy feasible and safe as a solo surgeon operation.[18] There are a number of other examples from around the world of how technology has

allowed operations to take place with reduced staff assistance to surgeons.[19,20,21]

Another example is in Taiwan, where anaesthesiologists used portable computers to log information during ward rounds about patients who need acute pain management. Previously, this information was recorded on a sheet of paper by anaesthesiologists and subsequently entered into the hospital mainframe computer by a nurse. To reduce the number of staff needed for this task, a personal digital assistant (PDA) was introduced so anaesthesiologists could record information directly into the PDA device at the bedside. The data was loaded into the main hospital computer system at the end of the ward rounds. Not only did this save staff time and reduce the number of specialists that needed to be involved, the information compiled was also more extensive.[22]

Another example comes from the US where a device that automates physical therapy helped to reduce patient supervision by therapists. When tested with people recovering from stroke, the device greatly reduced the supervision required from a therapist and was found to be as effective as standard one on one therapy.[23]

Empowering patients

New technologies are changing the dynamics of healthcare teams because patients are becoming more empowered.[24] In some instances, there is a move towards seeing patients as an integral part of their own care team, and this influences the level of other professional support required. Due to new technologies, patients may now have more information at their disposal, more control over scheduling appointments and more responsibility for monitoring their symptoms and outcomes.[25,26]

"Traditional notions of ambulatory care are changing from being provider-centred to becoming more patient-centric. A host of new remote monitoring and communication technologies are available so that providers can now interact with patients anywhere, anytime. The traditional care setting is shifting to where the patient is, rather than where the physician is located. Patients are the most underutilised resource in healthcare."[27]

An example is the patient scheduling system used by the US Veteran's Affairs system; a service which provides public sector healthcare for US military veterans and has developed a culture of innovation. In 1990 it was seen as a health service of last resort and the US Congress was considering disbanding it. In less than two decades the organisation is rivalling private sector services on quality performance measures and patient satisfaction.

Strong leadership was essential in this turnaround and technology was used extensively to help adopt and spread innovation. For example, the organisation used 'Advanced Access,' a scheduling system that allows patients to telephone and arrange an appointment on the same day.

Average appointment waiting times nationally fell from 60 days in 2000 to 25 days in 2004. Giving patients more responsibility for scheduling meant that administrative staff were able to be redeployed to support clinicians with administrative duties, which in turn gave clinicians more time to spend on direct patient care rather than paperwork.

There is some concern that patient centred technologies encounter a number of barriers to adoption, and are not always designed with the users in mind. In England, an evaluation of HealthSpace, an internet accessible personal electronic health record, found that unless such technologies align closely with people's attitudes, self management practices, information needs, the wider care package, organisational routines and incentive structures for clinicians, there is a risk that they will be abandoned or not adopted at all. Conceptualising new technologies dynamically as components of a broader network of care and focusing on user centred design techniques might improve their chances of adoption.[28]

As well as technologies deployed by the health service, a variety of new technologies are available for patients to purchase themselves in order to keep themselves well, and thus become a central part of their own care team. However, there is a lack of evidence about the impact of these 'smart technologies.'[29]

Changing the place of care

Throughout history the introduction of new technologies has influenced where care can be provided and by whom.[30] For instance, new technologies such as point of care screening devices, medication bar code readers and bedside scanners mean that nurses can provide care in wards rather than transferring patients to other parts of the hospital or undertaking preparation work elsewhere before visiting patients on wards. This also means that less senior nurses are able to undertake such tasks, as supervision is close by.

Furthermore, new technologies may enable healthcare staff to work offsite, including in the community and even at their own residences. For instance, in the US, one group of hospitals tested allowing administrative and finance workers and clinicians undertaking selected administrative duties to work at home.[31]

Working across organisations

Communication technology means that staff need not be located in the same physical location or organisation in order to form teams.[32] Practitioners from health, social care and community organisations can form learning networks, communities of practice or service provision teams, using information technology to share records and good practice. Such technologies can foster improved communication within organisations and also between organisations,[33] but there are few empirical evaluations of outcomes.

Working across regional areas

Communication technology also means that team members can be drawn from different geographical locales.[34,35,36]

For instance, in Australia, distance management was tested to support nurses in remote and rural locations. Here the line management team was located in a different geographical region from the workplace they managed. Surveys and interviews with nurses found that those working remotely from line management and other members of the team were very happy with the nature of their work and their level of autonomy, but they were also dissatisfied with aspects of infrastructure, support and management practices. Distance management was associated with inadequate resources, poor systems, unrealistic expectations and excessive workload. There was a frequent change of managers which may have contributed to the perceived lack of support. This study illustrates that while technology enables teams to be geographically dispersed, this is not without its challenges. The researchers suggested that greater use of new technologies could enhance communication and improve remote working.[37]

Telemedicine communication can be between patients and professionals or between two or more professionals.[38] With regard to professional-to-professional communication, telemedicine technologies have been tested to improve care for people recovering from stroke. A survey of specialists and other doctors in the US found that most had positive views about the value of telestroke care and thought it improved access and reduced geographic differences in stoke management. However they thought that patients preferred in person consultations.[39]

Another study examined transmission via the internet of low resolution images from automated screening of cervical cytology specimens. The researchers found that this approach has the potential to provide remote interpretation and thus allow centralisation of the cytology workforce.[40]

With teleconsultations, patients are in a different location from the team providing their care.[41] Medical support is provided through a video link. The patient and professional may be in different regions or even countries.[42] For instance, people in England could receive consultations from staff in Ireland or Scotland.

Researchers in the US examined whether a remote intensive care unit (ICU) programme could improve clinical and economic performance across multiple ICUs. The remote care service used intensivists and 'physician extenders' (assistants) to provide supplemental monitoring and management of ICU patients for 19 hours per day from a centralised off site facility. Supporting software, including electronic data display and a computer based decision support tool, was available in both the ICU and at the remote site. The remote system was associated with reduced hospital mortality and ICU length of stay, lower costs per case and higher hospital revenues (due to

increased volumes). The magnitude of improvements was similar to those from implementing on site dedicated intensivist staffing models.[43]

Technology has also been used to provide information and support to patients remotely, rather than solely consultations or diagnosis. For instance, in the UK Birmingham OwnHealth is a partnership between a PCT (the commissioner), a private sector provider (Pfizer Health Solutions), and NHS Direct (subcontracted by the private sector). The programme uses NHS Direct nurses and centralised call centre facilities to proactively support people with long term conditions with the aim of increasing self management and reducing unnecessary use of health services. The programme has reported measurable improvements in motivation to change, healthy behaviour and dietary change and a trend towards reduced use of hospital services.[44]

This example of using telecommunications and decision support technology suggests that there is much scope for diffusing innovations already developed in other countries or regions. However it takes time to adapt the models and language used elsewhere. In this instance, the decision support software used by nurse care managers was redeveloped and patients wanted to meet their care manager in person to put a face to a name (compared to US models which were wholly telephone based). There was also much more extensive liaison and integration with GP services required.

Following on from this, a UK study of nurses running telephone helplines with decision support software found that nurses developed new skills and were able to effectively support patients remotely. However the role could be stressful and some raised concerns about whether telenursing was 'real' nursing. This authors suggested that this reflects policy tensions between the need to develop new nursing skills including the use of technology, to improve efficiency and to recognise the worth of hands on nursing.[45]

Where the patient and medical practitioner are located in different jurisdictions, there may be issues about the regulation of medical service provision, the registration of medical practitioners and standardising medical education across national boundaries.[46,47] For example, in Australia, nurses providing telehealth services have to be registered across multiple states and territories.[48]

Most of the initiatives implemented in the UK have not encountered this difficulty, but concerns are being taken seriously internationally. For instance, many radiology screening images are now archived in a digital format and the advent of more powerful computers means that digital image transmission is becoming commonplace. This ability to move large diagnostic image datasets to display stations anywhere in the world using high speed data links creates issues with credentialing, quality assurance, licensure, privacy, jurisdiction and medical liability. In the US a special task force has been set up to consider these challenges.[49]

Researchers from Canada found that specialities relying on either thorough physical examinations or specialised investigative techniques are unlikely to
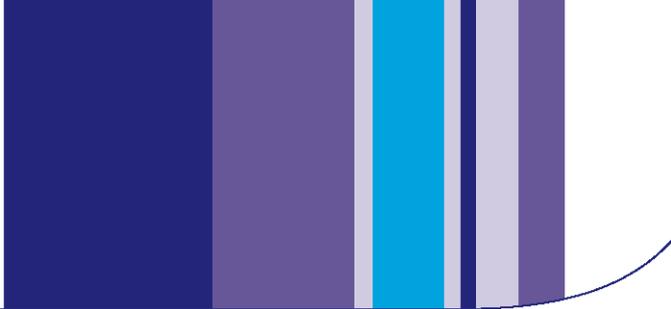
restructure their work routines to accommodate teleconsultation and these professionals may see this technology as limited. Specialities that primarily exploit images or numerical data tend to perceive teleconsultation as more useful. The perceived benefits of teleconsultation increase according to the distance the patient would have to travel to be seen directly by a consultant.[50]

How is technology being adopted?

Adoption models

This section examines how new technology is adopted by healthcare teams, including whether there is a 'lifecycle' of adoption which determines who uses the new technology and for how long before it is rolled out to the wider team.

Some have suggested that in the NHS uptake of new technologies and practices occurs slowly.[51,52] But the reasons for this are not widely understood.

"Implementing new methods, guidelines or tools into routine care ... is a slow and unpredictable process, and the factors that play a role in the change process are not yet fully understood."[53]

Research suggests that there are a range of factors determining how new technologies are adopted and rolled out. These include:[54]factors relating to the innovation itself such as relative advantage, complexity, compatibility, trialability and maturity characteristics of the adopting (or non adopting) individual such as cognitive capacities, attitudes perceptions, and behaviour patterns characteristics of adopting organisations such as size and structure, organisational climate, extent of resources and infrastructure, absorptive
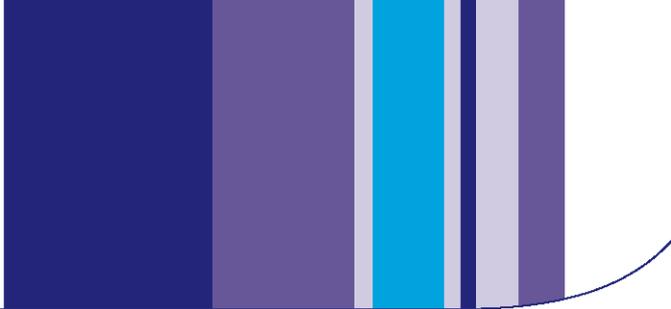
capacity, and 'connectedness' features of the wider environment such as external regulatory or market environment, national priorities and targets, external networks, and the demands of patient and advocacy groups.

This complexity of determinants means there is no standard 'lifecycle' for adopting new technology, but research has examined some of the key stages. The adoption process in health and social care is rarely linear, but it may helpful to think of its components as including discovery, adoption, diffusion and routinisation. Some have dubbed this the innovation pathway or cycle (see Figure 1), however in reality, the evidence suggests that innovation rarely corresponds to a linear model.[55]

We examine each of the phases briefly in turn before providing practical examples of factors influencing the uptake of new technologies in healthcare.

With regard to discovery, healthcare managers and teams may develop or adopt new technologies from internal or external sources. External channels include policy transfer from national or international healthcare systems, from other public sector settings, and from industry.[56]

The process through which healthcare organisations and teams discover new technologies remains somewhat ad hoc despite investments in horizon scanning and research and development.[57] NHS innovation hubs, NHS Evidence, NICE guidelines and other initiatives aim to support organisations to discover new technologies.

The use of new technologies has traditionally been associated with breakthroughs in clinical practice, so much of the responsibility for identifying new technologies has rested with senior medics.[58]

Adoption is an organisational or team decision to accept or reject an new technologies.[59] Within the NHS such decisions may be taken at different times by a range of individuals and organisations including commissioners, provider organisations and national bodies such as NICE. Adoption may also take place implicitly without a formal decision, but evidence and guidance about costs, benefits and risks is usually considered.[60]

Following adoption, diffusion is the process of adaptation required to accommodate the new technology within particular healthcare environments.[61]

Routinisation requires innovations to be made sustainable. It can be defined as the process through which new technologies are maintained for an appropriate period.[62] This requires new ways of working to become embedded into practice, performance management regimes and cultural norms.[63]

In addition to the innovation cycle, a number of other theories focus on the adoption of innovation, such as Rogers innovation-diffusion framework, the unified theory of acceptance and use of technology model, the change management framework, the organisational readiness for change

framework, the triangle of dependencies model, the clinical information technology innovation model, the fit between individuals, task and technology framework, Giddens' structuration theory, and Lewin's change theory, amongst others.[64,65,66,67,68,69,70,71] A description of such frameworks is outside the scope of this review, but it is important to acknowledge that extensive work has been undertaken in the field of innovation adoption more broadly, in both healthcare and beyond.[72,73,74]

Factors supporting spread

There are a variety of factors supporting the adoption and spread of new technologies in healthcare. For instance, a case study of implementing mobile nursing stations in Taiwan found that critical factors when adopting new technology include the degree of peer competition, governmental and insurance policies, the IT infrastructure, vendor selection, a clinical champion, top management support, clear communication about tasks, user participation and training issues.[75]

In Canada, researchers identified a range of key issues for optimal implementation of telehealth technologies including readiness of the environment; needs analysis, strategic business plans and diverse partnerships; equipment and IT vendors; staged implementation; and evaluation. Strong professional and technical policy standards were also required. Recognising the importance of human factors and workforce implications, the change process, and the changing culture were critical.[76]

Researchers in the US examined the facilitators and barriers to implementing a pharmacy barcode scanning system to reduce medication dispensing errors at a large hospital. Three main barriers to implementation were identified: i) process issues, including training requirements and process flow issues, ii) technology issues including hardware, software, and the role of vendors, and iii) resistance including communication issues, changing roles and negative perceptions about technology. Strategies to overcome these barriers included adequate training, continuous improvement, adaptation of workflow to address individual staff needs, ongoing vendor involvement, acknowledgment of technology limitations and attempts to address them, clear communication, identifying champions, emphasising the new information and benefits of the system, and facilitating collaboration.[77]

In England, researchers examined the introduction of centrally stored shared electronic patient records. They found that eight factors explained the lack of implementation in the NHS: i) properties of the technology including technical immaturity, lack of interoperability, and the extent to which potential adopters believed the benefits outweighed the risks; ii) staff concerns about workload and the ethics of sharing 'confidential' information using an implied consent model; iii) interpersonal influence such as opinion leaders, champions and facilitators; iv) organisational antecedents for innovation

such as past experience with information technology, leadership and management capacity, effective data capture systems, and resources and capacity; iv) organisational readiness for the new technology, including innovation-system fit, tension for change, power balances between supporters and opponents, and baseline data quality; vi) implementation process including the nature of the change model and the extent to which new routines aligned with existing organisational routines; vii) the nature and quality of links between different parts of the system; viii) the wider environment, especially the political context of the programme.

The authors concluded that:

> *"Shared electronic records are not plug-in technologies. They are complex innovations that must be accepted by individual patients and staff and also embedded in organisational and inter-organisational routines. This process is heavily influenced at the micro-level by the material properties of the technology, individuals attitudes and concerns, and interpersonal influence; at the meso-level by organisational antecedents, readiness, and operational aspects of implementation; and at the macro-level by institutional and socio-political forces."[78]*

In the Netherlands, factors affecting whether healthcare workers used internet technologies were related to technological issues such as the usability, design, and relevance of technologies; individual factors such as professionals' knowledge and experience; work related factors such as high work pressure; and organisational factors such as professional communication and training.[79]

These examples demonstrate that the factors influencing staff adoption and roll out of new technologies are complex and multifaceted.[80] Some of the most commonly researched factors supporting adoption include ease of use, environmental context, staff attitudes and engagement and staff skills and capacity. Each of these is explored briefly in turn.

Ease of use

A variety of tools and strategies for enhancing the adoption and roll out of new technologies are available, although there are varying levels of evidence of their effectiveness. However, a systematic review found that technological innovations that are simple to use and explicitly save everyone time and effort are relatively easy to implement, but technologies that primarily serve management or only specific staff groups may fail, despite considerable institutional effort. The authors concluded that:

> "*Successful implementation of ... technological changes requires visionary leadership that has carefully considered the benefits, consulted with influence leaders at all organisational levels to spot unintended consequences and sources of resistance, and developed a detailed plan and continuous quality assurance process to foster implementation over time."[81]*

A number of factors contribute to ease of use, including having the physical space available to use technology. In the US, teams implementing tele-health to facilitate immediate expert medical evaluations of alleged child abuse or neglect found that the adoption of new technologies were affected by unforeseen variables such as physical space limitations and examination room availability. Staff engagement early in the process resulted in a greater likelihood of using technology. Family concerns about patient privacy issues were rare and were resolved quickly by health care practitioners. Using the equipment itself was not difficult, but the physical environment had to be appropriate.[82]

Research also suggests that ease of access is important. Barriers to using new technologies include lack of access, poor availability of fast internet access, lack of IT or technology skills and knowledge, lack of time, concerns about costs and database security, lack of time, energy or motivation to learn new skills, competing priorities and a preference for other modalities.[83]

Supportive environment

No single approach will be successful in all settings. It is the interaction among the new technology, the intended audience and the context that determines the adoption rate. A case study of introducing webcams for COPD follow up care at a Dutch rehabilitation clinic found that when new technologies such as telecare are implemented, 'the same' technology will perform differently in various contexts. Not only that, but the technology will have varying impacts on the workforce and environment, depending on the context.

> *"In order to function at all, technology has to be tamed, it has to be tinkered with to fit the practices of the users. The technology, however, is not meekly put to use (tamed), but is unleashed as well, affecting care practices in unforeseen ways."[84]*

A receptive climate for using new technologies will develop incrementally over time as teams and organisations learn from and benefit from previous successes. Funding, space, time, leadership and staff engagement may all be part of this receptive climate.[85]

In Australia, information technology that had proven effectiveness in the US was rolled out but there were problems with diffusion including a lack of fit in the strategy-structure, strategy-structure-management processes, and strategy-structure-role relationships.[86]

Elsewhere in Australia, researchers found that critical factors for the successful introduction of hospital clinical information systems included a clear initial vision, strong clinical leadership and management at the departmental level, committed project management, and involvement of all staff, with appropriate training. Clinician engagement was essential for sustaining rollout of the new technologies.[87]
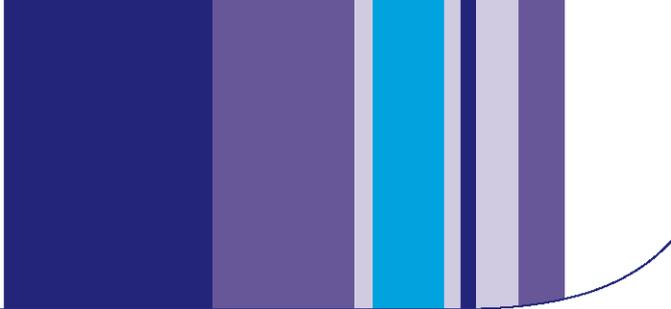
There has been a great deal of interest in computerised physician order entry systems as a tool for improving the quality and safety of patient care. Such systems could have a substantial impact on patients in intensive care, where the potential for medical error is high and the clinical workflow is demanding and complex. However in the US, in 2009 only about 17% of hospitals had functional computerised physician order entry systems in place. Factors affecting the uptake of the new technology included limited evidence of a beneficial effect on clinical outcomes, new error types arising from using these systems, effect on intensive care unit workflow, staff relationships and roles, and limited user acceptance of software design.[88] These factors all form part of the broader organisational climate in which technologies are launched.

In Sweden, a computer based test for lifestyle interventions was used in six primary care centres. Adoption of the new technology was positively influenced by positive expectations at the unit, perceptions of the innovation being compatible with existing routines and perceived advantages. Organisational changes and staff shortages were obstacles to adoption. The researchers concluded that when new technologies are introduced to primary care, factors to consider during planning include assessment of staff expectations, the perceived need for the innovation and its potential compatibility with existing routines.[89]

Attitudes and engagement

In order to help the healthcare workforce adopt new technologies, inter-functional and inter-organisational co-ordination and collaboration is required. Teams need to be encouraged to adapt new technologies to their own environments.[90] End users and other stakeholders should be engaged as active change agents rather than passive recipients of new technologies.[91]

Clinical champions have been found to facilitate staff engagement.

"Physician leadership has been shown to be a critical success factor for any successful technology implementation. An effective physician champion can help develop and promote a clear vision of an improved future, enlist the support of the physicians and staff, drive the process changes needs and manage the cultural change required."[92]

In the US, researchers suggest that doctors can lead the way in encouraging the adoption of new technologies.

"The perception had been that, given the current state of health care reimbursement, decisions to acquire radical and often expensive devices will centre around economic or strategic considerations. However, it was discovered that technology acquisition appeared to be a physician centred activity with less consideration given to strategic or economic factors."[93]

The attitudes of staff are crucially important.[94,95] A systematic review which included 13 studies investigated nurses' attitudes to health information technology such as electronic records. The reviewers found that in order for new technologies to be adopted, nurses must recognise that incorporating them into their daily practice is beneficial to patient outcomes. Those with greater experience using computers were most likely to be positive, so upskilling nurses in the use of computers may help to spread new technologies more quickly. The most common barriers to adopting new technologies were poor system design, system slowdown and system downtime. Nurses were also fearful that using technology could dehumanise patient care so involving nurses in system design and creating a positive, supportive atmosphere may help sustainability.[96]

The importance of staff attitudes has been demonstrated in hospitals, primary care, nursing homes, hospices and many other healthcare environments.[97,98,99]

E-health refers to the organisation and delivery of health services and information using the internet and related technologies. Researchers in England examined the extent to which NHS frontline staff are ready to implement such technologies including practice staff such as doctors, nurses, practice managers and receptionists who are expected to use new information technology and primary care trust staff who are involved in its implementation. Teams acknowledged the benefits that new technologies could bring to the workplace, but there were also some common concerns. There was a mistrust of technology and fears about the heavy initial workload involved in becoming fully computerised. The authors suggested that the success of new technologies depends on identifying, acknowledging and overcoming these concerns.[100]

Smartphones are phones which have access to the internet and other computer processing capabilities. Researchers in the US examined community hospital nurses' decisions about whether to use smartphones to support their work. They found that that individual intentions to use a smartphone were mostly determined by attitudes toward using a smartphone, which in turn were affected by innovation characteristics such as observability, compatibility, job relevance, internal environment and external environment. This illustrates how staff attitudes are linked to other environmental factors.[101]

Surveys suggest that work demands, access to computers and lack of support are the main barriers that nurses report to adopting new technologies in the workplace. Lack of interest is generally not a barrier.[102]

A survey of 91 Canadian nurses who used personal digital assistants for one month in their daily activities found that whether or not nurses' thought the technology would be useful was the main factor affecting the adoption of mobile technology.[103]

A study of the experiences of nurses and doctors who used a clinical decision support system in the critical care area found that staff were
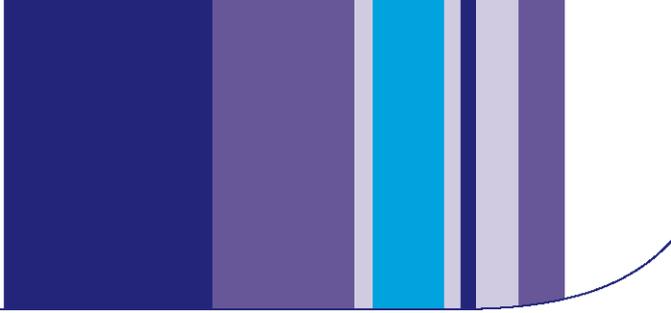
frustrated by a perceived lack of input into planning and a lack of training prior to implementation.[104] This suggests that when technologies are introduced it is important to involve and engage staff from the outset.

Research in the US found that clinicians were supportive of new technologies when they believed tools increased patient safety, professionalism and job satisfaction and when clinicians were supported by colleagues and leaders during the implementation process.[105]

Other research in the US tracked the attitudes of doctors provided with a PDA. Age, position in the hospital and beliefs about health IT were direct predictors of doctors' beliefs about PDAs prior to receiving one. Ease of use and perceptions of usefulness significantly influenced doctors' intent to adopt PDAs. However, these attitudes did not affect doctors' perceptions of usefulness after they had been provided with a PDA. This suggests that once professionals begin using a technology, their attitudes can change rapidly and become more positive.[106]

Informing managers and professionals about the availability of new technologies through formal published evidence, decision and dissemination support tools (such as guidelines), organisational and inter-organisational networks, leadership development, and evaluation and review have all been found useful in a variety of contexts.[107]

The development of cross boundary networks or 'communities of practice' is important to spreading new technologies and clinical and managerial leadership at all levels is an important facilitator of innovation.

Staff skills

Building an evidence base is important,[108] and so too is building up capacity and capability to adopt new technologies within frontline teams and organisations.[109,110] There may be some work to do to build staff capabilities. A study of over 4000 Australian nurses found that nurses recognise the benefits of adopting more information technology in the workplace but there are significant barriers, including deficits in the capacity of the nursing workforce to engage with electronic information.[111]

In the US, researchers examined why some practices are more likely to adopt electronic prescribing technologies than others. They found that members of practices that fully adopted new technologies had greater familiarity with and skills regarding the capabilities of health information technologies and had more modest expectations about potential benefits. Practices less likely to implement technologies reported limited understanding of e-prescribing capabilities, expected that the tool would increase the speed of clinical care and reported difficulties with technical aspects of implementation and insufficient technical support.[112] Similar findings about staff capacity and acceptance were found regarding health IT adoption in community health centres in Thailand.[113]

Elsewhere in the US, use of electronic health records in primary care was influenced by access to internal information technology support staff versus having to outsource for technical support services.[114]

A study in US nursing homes implementing clinical information systems found that both capacity and attitudes influenced the adoption of new technologies. Adoption and staff satisfaction could be enhanced by including a system lifecycle plan, using change management procedures, improving start up projections, hiring appropriately trained information technology staff, and providing a system support plan.[115]

Lifecycle of staff adoption

There is little empirical research available about whether there is a 'lifecycle' of adoption for new technologies which determines who uses the technology and for how long before it is rolled out to the wider team. Anecdotal evidence suggests that senior staff members tend to test the feasibility of technology before authorising more junior staff to use it in routine practice but we identified no studies that examined the timeframe for this or made comparisons between countries.

In Scotland, researchers evaluated whether structural characteristics of a general practice were associated with variations in use of a web based clinical information system. During the initial phase of implementation, only a few practices made very frequent use of the information system and relatively high numbers of practices used the facility infrequently. However, overall use gradually became more evenly spread, particularly among nurse users. Frequent use by GPs was evident in only a small number of practices and average use by GPs decreased as time went by. The authors concluded that practice nurses were critical in spreading uptake beyond initial GP enthusiasts and for sustained and rising use in subsequent years. Structural features of the practice did not influence use of the technology.[116]

Research is available about how long it takes for teams to learn about the features of new technologies, though this learning curve differs significantly depending on the technology of interest. For instance, a US study examined the learning curve for robotic assisted gynaecologic surgery. After about 50 cases, staff felt fully comfortable with the technology and the benefits began to be realised.[117]

What is the impact?

Impact on care processes

This section examines the impact of introducing new technologies and resulting changes in how staff and teams are organised on services, patients and practitioners.

There is evidence that new technologies can improve the quality of care processes by enhancing communication, standardising processes, and enhancing workflow, especially when used in addition to existing care rather than as a substitution.[118,119,120] For example, a survey of GP practices in Australia, Canada, Germany, the Netherlands, New Zealand, the United Kingdom and the US found that health systems that promote new technologies and information system infrastructure are better able to address care coordination and patient safety issues and maintain the satisfaction of GPs.[121]

In the US, the Personal Digital Assistance for Guideline Adherence (GLAD Heart) study aimed to improve adherence to cholesterol guidelines. A randomised controlled trial with 61 primary care practices found that the technology was feasible and had some impact on cholesterol management. The authors concluded that technology has the potential to improve the quality of care, but can also be relatively expensive.[122]

Introducing new technologies is not all 'plain sailing' and disruptions and negative impacts are possible as well. For instance, researchers in the US examined the effects of new technology on team communication and information flow in the complex work environment of operating theatres. Introducing a robot assisted cholecystectomy procedure disrupted teamwork and increased the complexity of information flow. New communication protocols had to be set up, and these helped to facilitate the use of the new technology.[123]

But not all research has positive outcomes. For instance, a one year audit of a website link set up to facilitate communication between GPs and sexual health clinic specialists in Australia was not successful. It was not well used by GPs, possibly due to discomfort with the technology, time added to workload, lack of direct perceived benefit and lack of immediate response from specialists.[124]

In England, researchers examined how electronic patient records influenced how staff interact with each other during critical care ward rounds compared with paper based records. Using video based analysis, observation and interviews, they found that the ward round team faced several difficulties when interacting with each other using the electronic record compared with paper records. The physical setup of the technology impeded consultants' ability to lead the ward round and prevented other clinical staff from contributing to discussions. Thus adopting new technology actually impeded

multidisciplinary communication during the ward round instead of facilitating it.[125]

It has been suggested that the huge array of technology now used in medicine may impact on the extent to which practitioners can 'care' and become emotionally engaged with patients. However the introduction of new technologies need not have a negative impact on patient care. In Ireland, research found that critical care nurses are able to transcend the obtrusive nature of technology to deliver expert caring to their patients. The study also found that life saving technology that supports the lives of critically ill patients can bring nurses very close to their patients and families.[126]

Impact on patient outcomes

There is extensive evidence that introducing new technologies can make a significant difference to the quality and safety of care.[127,128,129,130] For instance, proactive telecare assisted by decision support software has been found to improve clinical outcomes or reduce symptoms in people with depression,[131,132,133,134,135] heart disease,[136,137] diabetes,[138,139,140,141,142,143] asthma[144] and the frail elderly,[145] amongst others.

Similarly, telemedicine based consultations have been available for some years and more recently diagnostic services such as pathology and radiology are beginning to embrace this new technology. Teleradiology and telepathology allow medical services to be delivered across vast distances, including across national and international boundaries.[146] Using technology in this way can be particularly valuable in remote communities where transporting patients and medical practitioners is problematic.[147] Practitioners other than doctors deliver much of the healthcare in rural communities, so it has been suggested that it is essential to ensure that nurses and support staff are IT-enabled and technologically savvy.[148]

There are numerous examples of the benefits of new technologies. A literature review found that information technology supported a systematic approach to diabetes management in general practice. New information technologies have been used to support patients, enhance changes in healthcare delivery and provide clinicians with access to expertise and data about individual patients and populations. Such technologies have been associated improved diabetes symptoms and risk factors.[149]

Another example comes from the US, where a computer system was tested to help counsellors refer substance abuse patients to appropriate and available community services. The technology resulted in improved treatment planning and better patient performance during treatment. There were no differences in patient satisfaction compared to usual care.[150]

Impact on staff

Research suggests that new technologies can free up staff capacity, increase job satisfaction through better communication and enhance role responsibilities, by giving different grades of staff an opportunity to take part in new tasks.[151,152]

For instance in the UK, DNA probes have been introduced in clinical genetics services. Research suggests that this technology has reduced staff workload in comparison with other activities, but required geneticists to learn new communication skills in relation to patients and colleagues.[153]

However there may also be some downsides to implementing new technologies. Researchers in the US suggested that some staff may face redeployment or redundancy due to new technologies or it may be more difficult to enter or re-enter the workforce if greater technical skills are needed.[154,155] This largely affects non professionally qualified staff.

In the US, medical technologists from four clinical laboratories in a large teaching hospital were surveyed about the impacts of major technological and procedural change. Introducing new technologies was associated with occupational stress and job dissatisfaction. Staff reported that technological changes could be associated with work overload, feelings of uncertainty in the face of new technology, lack of direction from supervisors and lack of influence on management.[156]

Researchers in Australia found that introducing automated instrumentation and computerisation had a significant impact on the role, skills and employment prospect of laboratory scientists. Many traditional skills were being lost due to technological change.[157]

On the positive side, new technologies have an impact on how staff can be trained and updated.[158,159] Examples include simulation technology, accessing information via handheld devices, interactive dvds and online training.[160,161] Online technologies in particular mean that it is easier for staff to access information, share good practice and keep up to date with new research.[162,163,164,165,166,167]

For example, in a rural part of the US, Virtual Grand Rounds were tested for delivering continuing education to social workers and residential care coordinators in order to improve workforce retention. Participants were satisfied with the delivery method and thought that the material would impact on their practice.[168]

Technology also helps to address shortages in educators, as lectures can be beamed around the globe, potentially reaching a much wider audience.[169,170]

> *"Although appropriate use of technology offers potential for improved learning, there are other compelling reasons to use technology in medical education, such as reaching a different audience or accessing unique expertise that would otherwise be unavailable."* [171]

Research suggests that the use of technology in healthcare training has increased skills, access, distribution, innovation and collaboration.[172,173,174,175] Providing training across regional or national boundaries has benefits for cultural competence and diversity.[176] It may also help with the retention of staff if people are able to access training and development opportunities more easily, or know that ongoing support will be available via telehealth technologies.[177,178,179,180,181]

A systematic review of 57 studies found that the main barriers to e-learning among health professionals include cost, poorly designed packages, inadequate technology, lack of skills, desire for some face to face teaching, the time intensive nature of e-learning and computer anxiety. The main solutions suggested were standardisation, funding, integration of e-learning into the curriculum, blended teaching, user friendly packages, access to technology, skills training, support, employers paying e-learning costs and dedicated work time for e-learning.[182]

However, there are also challenges including keeping up with the technology, the increased pace of training, depersonalisation, and fear of the unknown.[183,184,185,186,187,188] It has been suggested that in order to avoid negative impacts, staff must be helped to feel secure, needed and appreciated. Factors such as the need for security and freedom from stress, social belongingness, self esteem, self actualisation, stable work and social environments and new opportunities for learning and self definition must be considered.[189]

The presence of new technologies means that there is a requirement to train staff about these technologies.[190,191,192,193,194] Literature suggests that nurses and allied professionals think that computer skills should be taught as part of the undergraduate curriculum or as basic training and that staff are willing to undertake web based learning for continuing professional development in this area.[195,196] Other useful core training may include information literacy, privacy and security of health information, and techniques for identifying and adopting new technologies.[197,198,199] In the NHS, assessing and training teams in technical skills may be a priority[200] as some studies suggest that practitioners may not have the competencies required to use new technologies appropriately.[201]

Whether or not formal training is provided, staff need enough time to learn about and practice using new technologies and this may impact on workload initially.[202,203,204]
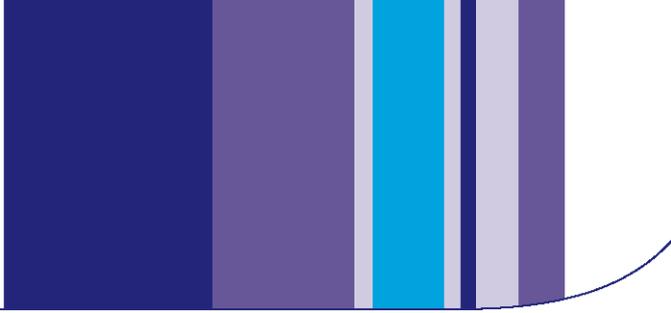
Some suggest that the age of healthcare workers influences the extent to which they feel comfortable with new technologies. Generation Y workers are becoming more common in the healthcare sector and the sustainability of future healthcare is dependent on this group of workers. This generation is more confident with technology and may move from one working environment to another. The healthcare system has a hierarchical structure in terms of operations and information structure, which may not work well for these staff. Researchers suggest that these workers have very different expectations about technology use and design, but there are few empirical studies about potential impacts.[205]

Impact on resource use

There are mixed findings about the impact of introducing new technologies on productivity, efficiency, value for money and healthcare resource use.[206,207]

There are a number of examples of positive outcomes.[208,209,210,211] For example in Taiwan, health information technology has been used to enhance care for older people. Telehealth provided in people's homes, in the community and in residential care enabled older people with long term conditions to live independently, was associated with reduced readmissions to hospital and helped those in institutions access acute care more efficiently.[212]

Another study from Taiwan found that PDAs used during ward rounds reduced the staff time needed to collect and input information about patients.[213]

In the US, an automated interactive voice system was used to respond to selected calls to a poison centre. The system was implemented successfully and did the job of four full time staff members. Evaluators concluded that using new technology in this way was an efficient and effective alternative that allowed for better staff utilisation.[214]

Research suggests that cell phone applications can significantly reduce the cost of treating young people with severe asthma due to more frequent communication between patients and their medical teams, and by motivating patients to become more engaged and knowledgeable about their care.[215]

Electronic prescribing systems have been widely implemented. Researchers in the US tested a computerised physician order entry system for surgical patients. Four additional informational technology specialists were temporarily required to help when implementing the system. But after adoption, 11 ancillary personnel (20%) were no longer required. The researchers concluded that this technology supported major efficiency gains.[216]

In Berlin, implementing a digital infrastructure in radiology helped to improve efficiency. The researchers suggest that success factors included implementing the new technology comprehensively, adapting workflow to fit in with the new technology and using automation to its full potential.[217]

There are also positive findings from the third sector. A US long term care facility providing care for people with dementia used a videoconferencing system to build links with local inpatient psychiatric care. Psychiatric admissions were reduced following implementation. The researchers concluded that inexpensive technology which transfers information over standard telephone lines can be successfully used in long term care settings to reduce healthcare resource use and associated costs.[218]

However other studies have less positive findings. Researchers in the US compared the cost of screening women for breast cancer using a mobile mammography unit rather than traditional hospital based equipment. They found that although mobile mammography was a more effective way to screen older women, the absolute cost per screen of mobile units is higher so financial barriers may impede widespread usage.[219]

Shortages of laboratory technicians has led to using automated assisted screening to increase productivity. However, some studies suggest that screening more cases more promptly could reduce the accuracy of laboratory screening. Thus any gains in speed are counterbalanced by impacts on accuracy or the cost of redoing tests.[220]

These differences in findings about productivity, efficiency and cost effectiveness may be due to the heterogeneity of technologies under review, but there may also be methodological difficulties.[221] It is difficult to measure the cost effectiveness of new technologies because their benefits may be confounded by the time taken to learn to use them properly. A new technology used by fully trained and experienced staff may be cost effective, but this may not be the case during the initial learning curve.[222] Furthermore, organisations implementing new technologies may experience delays, inefficient use of resources and new kinds of errors attributable to ineffective use of the technology.[223] All of these factors impact on cost effectiveness and productivity analyses conducted during early implementation.

Also, introducing new technologies alone may not be the most efficient and cost effective. Instead, combining new technologies with other system redesign elements and strong leadership may be most beneficial.[224] This approach is supported by researchers in the US who examined the impact of three different models organising intensive care: tiered regionalisation, intensive care unit telemedicine and quality improvement through regional outreach. They concluded that existing evidence does not strongly support exclusive use of one particular model and that it would be feasible to develop a hybrid model integrating all three approaches.[225]

Summary

Impact on staff organisation

Research suggests that new technologies are influencing how staff are organised in several key ways:

Improvements in technology mean that less qualified or experienced staff can provide diagnosis and care that might previously have been the preserve of higher grades or more specialised staff.

Communication technology means that teams can be drawn from different organisations and disciplines, meaning that more interprofessional collaboration and learning is possible.

Communication technology means that teams can provide care remotely for patients. This may reduce travelling time for staff and patients, thereby increasing capacity. However relatively senior or experienced staff are usually required for remote consultations.

Technological advances mean that patients can take more responsibility for care and can become part of the care team, for instance monitoring their blood sugar or blood glucose and sending data via telephone lines to practitioners. This means that professionals may need to learn to relate to patients in a different way, as a core part of the care team.

There is little evidence about whether introducing new technologies increases or reduces working hours or impacts on teams in other such practical ways. Case studies about particular technologies and organisations are available but this does not translate into generalisable trends. This is largely because the introduction of new technology differs depending on the organisational and team context.

However there is relatively little research in this area and a real need to develop a much greater knowledge base with appropriate methodologies and survey tools.[226,227,228,229] Often there is no systematic follow up of how new technologies have been integrated into work practices, although there are some exceptions.[230,231]

Adopting technology

There is no standard lifecycle by which new technologies are adapted by staff, because there are significant variations between teams and organisations.[232] There are no clear patterns according to the country in which a technology is introduced either.[233] A more important influence appears to be organisational and clinical leadership, the extent of a culture of innovation and other incentives.

"Rates of adoption of new technology or innovatory practices depend upon their inherent managerial and clinical incentives. Rates will be highest where these incentives coincide and lowest where both are weak."[234]

The 'innovation cycle' suggests that the roll out of new technologies tends to follow the process of discovery, adoption, diffusion and routinisation, however the evidence suggests that innovation rarely corresponds to a linear model and that these stages may sometimes happen simultaneously.

There is some evidence that consultants and senior grade staff are more likely to have access to new technologies first before allowing roll out to more junior staff once the technologies have been tested. However this is not always the case, and technologies designed to support administrative or junior functions tend to be tested immediately by the staff involved.

In many parts of the world senior medics were traditionally responsible for bringing new technologies to the attention of their organisations. The advent of horizon scanning resources, clinical guidelines and policy initiatives mean that senior clinicians are no longer the only ones on the lookout for new technologies.

Roll out mandated by centralised or managerial sources may be slower than that built upon a social movement approach, local champions or informal social structures,[235] however there is limited empirical evidence about the average time it takes to adopt and diffuse technological innovations in different contexts. Focusing on the perceived advantages of new technologies, the perceived need, values held by staff peers and leaders, and communication mechanisms speeds the adoption of new technologies by healthcare professionals.[236,237]

The literature about adopting new technologies is vast but suffers from a number of gaps and weaknesses.[238,239,240,241] For instance, much of the empirical evidence relates to traditional medical innovations. Fewer studies are available about more complex interventions. Recently researchers have sought to understand the organisational and system factors that impede or facilitate innovation[242] but few studies employ a systematic design and even fewer explore underpinning theories (or models) of change.[243,244]

Impact of technology

New technical, information and communication technologies can support and drive innovative work practice and research in healthcare.[245,246] There are numerous examples of how specific technologies have improved care delivery processes, patient outcomes, staff workload and satisfaction and resource use and cost effectiveness.

And new technologies need not be 'high tech.' Even introducing tools such as whiteboards or electronic whiteboards can influence how staff interact with each other and organise their workload.[247,248] For instance, in the US researchers examined how using a whiteboard in a trauma operating suite and an A&E department influenced staff interactions. The whiteboard supported collaborative work through task management, team attention

management, task status tracking, task articulation, resource planning and tracking, synchronous and asynchronous communication, multidisciplinary problem solving and negotiation, and socialisation and team building. It was not just the tool itself, but also its placement and installation method that made it highly interactive and usable. This illustrates that the context in which tools are used and their adoption and engagement are perhaps as important as the tools themselves.[249]

The context in which new technology is implemented is a key factor influencing the impact on staff and patients and its ultimate sustainability.[250]

> *"Critical research is key for improving what we know about the impact of innovations on healthcare delivery and people's lives and for using them in the most appropriate way. That implies clarifying the contexts in which innovation proves clinically and socially valuable or not."*[251]

But some suggest that there is much work to do to fully utilise technology in healthcare and gain benefits for staff, patients and processes.

> *"Incorporation of advances in information communications technology (ICT) into the workplace has had a major impact in human resource utilisation in sectors of the economy where it has occurred in a substantial manner, such as manufacturing and financial services. While some benefits of ICT have been realised in healthcare, the full impact of its benefits will only be realised if it is incorporated in a systematic form, rather than in the current patchy and uneven manner."*[252]

Studies in the UK suggest that healthcare staff are not using new technologies and information and communications systems in a structured way. The reasons are complex and include time, human factors, technological factors, lack of information, access to materials and financial resources.[253,254]

It is impossible to summarise the impact of new technologies as each technology has its distinct pros and cons. In general, implementing new technologies is seen as positive, though not without pitfalls. It may take time to introduce new systems, there may be resistance from managers, practitioners and patients, and practical implementation issues may need to be ironed out.[255]

The introduction of new technology alone does not guarantee positive outcomes.[256,257] Instead, simultaneous reengineering of people and processes is needed to exponentially increase the value of technology to an organisation.[258,259,260] Researchers suggest that technology is an important component of healthcare transformation, alongside leadership, financial resources, personal and organisational relationships, engagement with patients and families, improvement approaches, care coordination and staff development.[261,262,263,264,265,266,267]

Whilst attention has focused on the important role of new technologies and leaders in transforming healthcare,[268] less time has been spent on the issue of the workforce necessary to sustain the technologies and achieve their potential.[269,270,271] For instance, systematic reviews suggest that the professionals staffing telehealth programmes require specific skills and personality traits.[272]

This review has examined how staff and teams are currently being organised differently as a result of new technology, but perhaps an equally important question is how should staff be organised to maximise the benefits of new technologies and maintain staff and patient outcomes.

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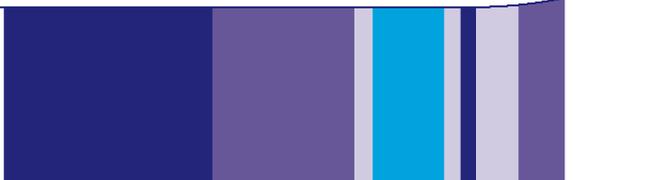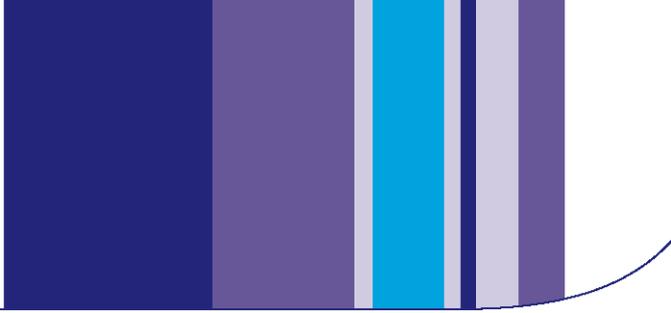
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