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DOI

<https://doi.org/10.1136/bmjqs-2019-009932>

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Implementation of clinical decision support to manage acute kidney injury in secondary care: an ethnographic study

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Received 14 June 2019

Revised 5 November 2019

Accepted 6 November 2019



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To cite: Bailey S, Hunt C, Brisley A, et al. *BMJ Qual Saf* Epub ahead of print: [please include Day Month Year]. doi:10.1136/bmjqs-2019-009932

ABSTRACT

Background Over the past decade, acute kidney injury (AKI) has become a global priority for improving patient safety and health outcomes. In the UK, a confidential inquiry into AKI led to the publication of clinical guidance and a range of policy initiatives. National patient safety directives have focused on the mandatory establishment of clinical decision support systems (CDSSs) within all acute National Health Service (NHS) trusts to improve the detection, alerting and response to AKI. We studied the organisational work of implementing AKI CDSSs within routine hospital care.

Methods An ethnographic study comprising non-participant observation and interviews was conducted in two NHS hospitals, delivering AKI quality improvement programmes, located in one region of England. Three researchers conducted a total of 49 interviews and 150 hours of observation over an 18-month period. Analysis was conducted collaboratively and iteratively around emergent themes, relating to the organisational work of technology adoption.

Results The two hospitals developed and implemented AKI CDSSs using very different approaches. Nevertheless, both resulted in adaptive work and trade-offs relating to the technology, the users, the organisation and the wider system of care. A common tension was associated with attempts to maximise benefit while minimise additional burden. In both hospitals, resource pressures exacerbated the tensions of translating AKI recommendations into routine practice.

Conclusions Our analysis highlights a conflicted relationship between external context (policy and resources), and organisational structure and culture (eg, digital capability, attitudes to quality improvement). Greater consideration is required to the long-term effectiveness of the approaches taken, particularly in light of the ongoing need for adaptation to incorporate new practices into routine work.

INTRODUCTION

Over the past decade, acute kidney injury (AKI) has become a global priority for improving patient safety and health outcomes.¹⁻⁴ AKI is a common and serious clinical syndrome characterised by sudden reduction in kidney function.

It has many causes but most often occurs during episodes of acute illness such as gastroenteritis or influenza.^{1 5} AKI complicates approximately 6% of all hospital admissions, and is associated with significant morbidity and high levels of mortality.^{2 6 7} The associated healthcare costs are substantial; in England, hospital AKI-related care alone accounts for around 1% of the total National Health Service (NHS) budget (£1.02 billion).⁸

In the UK, the 2009 National Confidential Inquiry into Patient Outcome and Death (NCEPOD) report on AKI, *Adding Insult to Injury*, found that up to one in five episodes of AKI were avoidable and only 50% of care associated with AKI could be considered 'good'.⁹ The report highlighted poor assessment of acute illness with delays in the recognition of AKI.⁹ To address identified gaps in quality and safety, a range of national initiatives were introduced including guidelines and quality standards.^{5 10-12} NHS England established the 'Think Kidneys' programme to improve care in hospital and community settings.¹³ A major driver for change has been the introduction of a mandatory NHS England Patient Safety Directive, which came into effect in March 2015. This required all NHS Acute and Foundation Trusts in England to implement a computerised algorithm within laboratory information management systems (LIMS) to standardise the identification of AKI.^{12 14} Locating the algorithm within the hospital LIMS was intended to enable integration with patient records, permit extraction of data to be sent to the UK Renal Registry and facilitate future roll-out to primary care. All major LIMS providers committed to

providing the algorithm on a commercially available LIMS by July 2014.¹⁵ This was followed in 2016 by a further patient safety directive requiring all NHS providers to ‘develop an action plan’ to ‘improve local systems and processes for the care of patients with AKI’.^{12 14 16 17}

Based on an international classification system for AKI, it is recommended that a “clinical decision support system” (CDSS) comprises three phases: a *detection* phase entailing installation of the national algorithm resulting in generation of AKI warning stage test results; an *alerting* phase entailing communication of warning stage test results to relevant clinical teams (ie, an e-alert); and a *response* phase to ensure an AKI warning stage test result is placed in clinical context leading to accurate diagnosis and effective management.^{1 14 18}

The implementation of CDSSs is regarded by policy makers as important in reducing both variation and costs in care.¹⁹ Research has highlighted that the introduction of CDSSs may impact on workforce planning through ‘new roles, new organisational functions and considerable management time’.²⁰ There remain gaps in our understanding of how new CDSSs are integrated into the ‘workflow’, across diverse settings and at what cost.^{21 22} Being mindful of the relationship between recommended practice (work-as-imagined) and everyday clinical work (work-as-done) is increasingly recognised as an approach to improve resilience and safety in healthcare settings.^{23–25} As defined by Hollnagel, ‘*Work-As-Imagined...describes what should happen under normal working conditions. Work-As-Done...on the other hand, describes what actually happens, how work unfolds over time in complex contexts*’.²⁵ Through studying the implementation of AKI CDSSs, using ethnographic methods, we explored the professional and organisational work surrounding the translation of policy drivers and clinical guidance into routine hospital care.

METHODS

Setting

This paper describes the implementation of two AKI CDSSs at neighbouring NHS hospital trusts in England. Both trusts were teaching hospitals with tertiary renal services and provided acute and specialist services to a mixed urban patient population of around 1.5 million people. Both hospitals had capacity of over 800 beds. They had each made improvements to AKI identification and management in the past and sought to use the introduction of the algorithm as an opportunity to formalise and focus on these programmes of ongoing work. The research was undertaken as part of the National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care Greater Manchester. Both hospitals were existing partners in the collaboration, and the protocol

Table 1 Data collection

	Hospital X	Hospital Y
Interviews (total)	24	25
Managers	6	7
Clinicians	8	5
Nurses	4	9
Pharmacists	0	1
Patients	6*	3

*One interview was conducted with patient and carer together.

for the study was developed collaboratively between researchers and partners.

Both hospitals mobilised aspects of quality improvement (QI) methodologies set out by the Institute for Healthcare Improvement (IHI).²⁶ However, they took different approaches and used them in different ways. Hospital X adopted the Breakthrough Series Collaborative approach (hereafter: ‘collaborative’), while in Hospital Y a ‘change agent’ approach was taken through the employment of AKI specialist nurses combined with an IHI-informed programme of system redesign. These differing approaches underscored the rationale for the research, in offering contrasting approaches to the implementation of a nationally mandated programme. At the same time the aims and objectives of each programme were broadly similar, with both sites including similar outcomes and process measures. It was the iterative process of developing a system for coordinating the alert that became the focus of research at each site.

Data collection

The study took an ethnographic approach comprising observations and semistructured interviews within the two hospital trusts (see table 1). Over the course of an 18-month period between November 2015 and September 2017, a total of 49 interviews were conducted with key personnel involved in the implementation process, and patients who had received care at one of the two sites. The research team also recorded around 150 hours of observations.

Data collection in each site was driven by an exploratory ethnographic inquiry into ‘how things are done around here’.²⁷ Researchers began by constructing a detailed account of the approach taken to QI in each site, and the formal and informal organisational conditions in which this approach was situated. This provided the basis for examining the different kinds of work involved in *doing* improvement.²⁸ In Hospital X, data collection commenced just as the collaborative phase of the QI programme was launched. This was a 12-month programme built around ‘Plan-Do-Study-Act’ (PDSA) cycles and comprising bimonthly collective learning events interspersed with ward-based testing and feedback events. These events comprised the main component of the research observation. Interviews were conducted

first with key clinical and managerial personnel associated with the QI programme and then with clinical ward staff. These interviews were used to situate the QI programme in context from a variety of perspectives and explore perceived barriers and facilitators to its progress. In Hospital Y the QI work had been piloted prior to data collection and a 'spread' phase was being undertaken by two specialist AKI nurses. Data collection began with interviews and conversations with the nurses and the associated team in order to reconstruct the improvement process. A snowballing approach was then taken to identify further relevant interviewees, with whom to explore different perspectives on the process. Observations comprised shadowing the specialist nurses and observing their interactions with ward-based teams. All interviews were digitally recorded, securely transcribed and anonymised.

Data analysis

In line with accepted conventions of ethnographic research, analysis took place on an iterative basis throughout data collection, with each new interview or observation informing the next.²⁹ Observational and interview notes were recorded in journals and discussed at regular team meetings. Emergent themes were identified and incorporated into interview topic guides, increasing focus as data collection progressed. Interview transcriptions were thematically analysed in order to develop a contextualised account of the implementation processes according to the observed differences between approaches to improvement, and the relationship between internal and external environment. Building on previous studies of CDSSs, our focus was on the 'work' of adaptation that characterises the adoption of new technology.²⁰ Analysis drew our attention to a complex relationship between the objectives of AKI policy, the technology mobilised to accomplish them and the resources available to organisations to support the introduction of the new system. Here, we theorise this relationship by drawing on the relationship between work-as-imagined and work-as-done.²⁵

RESULTS

Within the time frame of our study both hospitals documented some success in relation to their outcome and process targets. Monitoring and reporting of these outcomes was undertaken internally by each trust, and is reported in the study research report.³⁰ Our data collection and analysis focused on the process of implementation.

Though the two trusts had contrasting approaches to the implementation of AKI policies and guidance, a common tension experienced in both settings was finding a balance between the benefit and the burden associated with the introduction of new systems. The following sections describe the unfolding approaches to introducing an AKI CDSS and how, in both hospitals, resource pressures, particularly on ward-staffing

levels, exacerbated the tensions of translating recommendations into routine and sustainable practice.

Different approaches to introducing an AKI CDSS

Hospital X—collaborative approach

The approach of Hospital X was based on IHI collaborative methodology but had been adapted to fit the organisation's structure and culture. The IHI method emphasises incorporating learning into day-to-day working routines. There was an established history of QI work at Hospital X prior to the AKI programme, with a dedicated QI team. They claimed to have an 'improvement culture' which included a set of norms, values and 'ways of doing things'. A critical part of the 'collaborative' methodology was the development of 'tests of change', which are small, practical techniques that wards developed iteratively through PDSA cycles.

Hospital X's AKI collaborative included an AKI working group, with clinicians from nephrology, acute medical and intensive care, and representatives from pharmacy, nursing, information technology, biochemistry, and the QI team. Ten wards took part in the collaborative, which was based around five 'learning sessions' held between August 2015 and December 2016. The aim of the collaborative was to develop and test a series of ward-based changes, to be developed into a 'change package' and spread to the rest of the hospital following the collaborative programme.

A key element of the collaborative learning sessions was for each ward team to consider how they would ensure appropriate actions in the response phase following an AKI e-alert. The care bundle (see [box 1](#)) drew directly on national guidance (see [table 2](#)).¹³ At the start of the collaborative, learning sessions were

Box 1 Hospital X—AKI care bundle

Hospital X

Acute kidney injury (AKI)

Care Process Bundle

Investigate for cause of AKI; for example, sepsis or obstruction

Urine dipstick test within 24 hours of first AKI alert

Fluid balance assessment

Stop ACE inhibitors and ARBs** and pharmacy

medication review within 24 hours of first AKI alert

Serum creatinine test repeated within 24 hours of first AKI alert

Ultrasound scan of urinary tract within 24 hours of first AKI alert

Specialist renal or critical care discussion within 12 hours of first AKI alert

Written self-management information prior to discharge

*ACE inhibitor and angiotensin II receptor blockers (ARBs): pharmaceutical drugs used in the treatment of hypertension.

Table 2 Summary of acute kidney injury (AKI) quality standard and statements, process measures and core elements of a care bundle^{5 10 13 42}

NICE Quality standard for AKI (QS76) 2014	Advancing quality AKI clinical process measures 2015	Think Kidneys Core elements of AKI care bundle 2015
<p>Statement 1: People who are at risk of acute kidney injury are made aware of the potential causes.</p> <p>Statement 2: People who present with an illness with no clear acute component and one or more indications or risk factors for acute kidney injury are assessed for this condition.</p> <p>Statement 3: People in hospital who are at risk of acute kidney injury have their serum creatinine level and urine output monitored.</p> <p>Statement 4: People have a urine dipstick test performed as soon as acute kidney injury is suspected or detected.</p> <p>Statement 5: People with acute kidney injury have the management of their condition discussed with a nephrologist as soon as possible, and within 24 hours of detection, if they are at risk of intrinsic renal disease or have stage III acute kidney injury or a renal transplant.</p> <p>Statement 6: People with acute kidney injury who meet the criteria for renal replacement therapy are referred immediately to a nephrologist or critical care specialist.</p>	<p>AKI-01 Urine dipstick test within 24 hours of first AKI alert</p> <p>AKI-02 Stop ACE inhibitor and angiotensin receptor blockers (ARBs) within 24 hours of first AKI alert</p> <p>AKI-03 Serum creatinine test repeated within 24 hours of first AKI alert</p> <p>AKI-04 Ultrasound scan within 24 hours of first alert</p> <p>AKI-05 Specialist renal/critical care discussion within 12 hours of first AKI alert</p> <p>AKI-06 Give patients written self-management information prior to discharge</p> <p>AKI-07 Pharmacy medication review—data collection measure only</p>	<p>Initial assessment ABCDE as assessment* (follow NICE CG50†) observations—check NEWS Score‡ Look for signs of sepsis Abdominal palpation looking for full bladder</p> <p>Initial treatment Prompt treatment of sepsis (start Sepsis Six care bundle) Fluid challenges if hypovolaemic/hypotensive Medication review Stop potentially harmful drugs Check for dose adjustments in AKI Relieve obstruction (see guidance)</p>

*A method for assessing each of a patient's vital systems—Airway, Breathing, Circulation, Disability and Exposure.

†<https://www.nice.org.uk/guidance/cg50>

‡National Early Warning Score: <https://www.england.nhs.uk/ourwork/clinical-policy/sepsis/nationalearlywarningscore/>.

NICE, National Institute for Clinical Excellence.

scheduled for a full day. As time progressed and the organisation faced mounting staffing pressures, attendance at learning sessions diminished. In response to these pressures and the effect they were having on the time ward staff could dedicate to the collaborative, the QI team shortened learning sessions to half a day. This reduction in time resulted in changes to the focus of the sessions. Much of what had been included in the previous sessions, such as team-building exercises, extended periods for sharing ideas, patient narratives and group discussion were dropped. This meant that the ongoing monitoring and reporting of data made up the majority of the agenda. Furthermore, the plan for spreading the change package had to be delayed in light of staffing pressures.

Hospital Y—change agent approach

In 2011, Hospital Y undertook an internal audit of AKI services to compare the findings to the NCEPOD report findings.⁹ The audit found widespread variability between wards with regards AKI detection and management, which led to the formation in 2013 of an Acute Kidney Team. This consisted of three nephrologists, an intensivist, an acute physician, a part-time renal nurse specialist, a renal pharmacist and an IT developer. The team worked collaboratively on designing an improvement framework and

IT system to better manage AKI and provided quarterly reports to the Trust Board through the medical director. A steering group and working group established a business case for AKI nurse specialist funding. Between 2014 and 2015, the hospital undertook a 12-month programme of IHI-informed improvement education, in which key personnel involved in the AKI work designed and piloted an AKI intervention. Specific objectives of the QI project were to ensure: prompt recognition of AKI within 24 hours; appropriate medication reviews; appropriate fluid management; and adherence to all aspects of a checklist.

The intervention was tested using a factorial design on four wards with the support of one AKI nurse specialist for this period. Through use of PDSA cycles, the pilot focused on testing various combinations of improvement activities, leading to a set of interventions that could be spread hospital-wide. This included the development of a priority checklist for completion by ward staff for all cases of AKI (see [box 2](#)). As a result, by the time the NHS England Patient Safety Directive was mandated, Hospital Y had already developed its own AKI CDSS. In March 2015, informed by the findings from the pilot, two AKI nurse specialists were appointed on an ongoing basis to support spread across all wards.

Box 2 Hospital Y—Priority Care Checklist**Hospital Y****Acute kidney injury (AKI)****Priority Care Checklist**

- Ascertain baseline creatinine
- Identify cause for AKI
- Perform fluid assessment
- Investigate for cause and consequences
- Consider catheterisation
- Renal and bladder ultrasound scan
- Consider referral to renal
- Fluid balance charts
- Perform and document urine dipstick
- Perform drug review

AKI detection, alerting and response: contrasting approaches**Detection to alerting**

Hospital X adopted the national algorithm for detecting potential cases of AKI. The collaborative invested considerable work to set up an effective system that could be integrated into the electronic patient record. They expected that the e-alert would trigger actions that would be implemented by staff to halt the progression of AKI and provide clear advice to non-renal specialists about the referral pathway. The e-alert appeared in the record's demographic banner, which is a constant 'header' on the computer screen when clinical staff interact with a patient's medical record. Additionally, the e-alert was accompanied by a phone call from biochemistry to the ward where the blood sample had been taken for every new AKI stage 3 result.

Hospital Y implemented their own internally developed AKI algorithm, which was more sensitive than the national algorithm, which they claimed eradicated underdetection. One of the consequences of this was increased overidentification. Using their own system, Hospital Y estimated a prevalence of approximately 5% overidentification. Against this, they observed approximately 10% underidentification of true AKIs using the national system. They chose to accept over-detection because the nurse specialists were on hand to assess all cases and could discount any cases that they felt were not valid.

In contrast to Hospital X, Hospital Y did not have a fully integrated electronic patient record. In Hospital X the e-alert was present in the demographic banner at all times, whereas in Hospital Y the e-alert was associated with the blood results software on the computer, away from the paper notes. Therefore, in Hospital Y the nurse specialists were a dedicated resource that placed the AKI warning stage test result in the clinical context, checking and correcting any inaccuracies produced by the detection algorithm. The nurse specialists attached stickers to the notes of each patient with AKI; with sticker colours coded to alert nursing

staff, doctors and pharmacists to relevant sections. To ensure that the information was being communicated effectively, the nurse specialists conducted daily ward rounds. In effect, the nurses in Hospital Y acted as a *human* alert to the AKI e-alert. In Hospital X, in an effort to reduce missing patients, pharmacists performed a medication review for all the AKI e-alerts.

Alerting to response

In Hospital X, once an alert had been triggered, a list of tasks described in the 'AKI bundle' (see [box 1](#)) would then need to be completed for every suspected case of AKI. The bundle process was built into the electronic record, but the AKI working group decided not to make completion mandatory because they were worried about alert fatigue (that is, a failure to engage with digital prompts) and of adding to the bureaucratic burden faced by ward staff in their day-to-day work.³¹ This meant the working group had to think of alternative ways to ensure the checklist was completed. They assumed that the majority of nurses and clinicians would complete the checklist. In reality however, the checklist was completed in a minority of all the recorded AKI cases, as the following quote illustrates:

I see junior doctors, for example, working on the computer and pop-ups will appear repeatedly alerting them to various things, they definitely don't read them. They just regard it as an annoyance and a nuisance and they skip over it as fast as they can. (Manager 1—Hospital X)

During the initial period of Hospital X's collaborative, a nurse on the ward was nominated as the AKI coordinator each day to ensure there was distributed responsibility. The objective of the AKI coordinator was to ensure that the AKI care bundle (see [box 1](#)) was completed and, as such, the system was reliant on the coordinator role. However, despite the initial idea of distributed responsibility, the AKI coordinator role was often left to the ward coordinator. This suggests that the care bundle was not a process that was simply absorbed into other clinical practices but something that required additional time in the process of care to be completed. In addition, the existence of multiple, simultaneous QI programmes, and other increasingly competing demands on ward staff, created a tension for staff as to where to focus their time.

People were very eager to take part and went out thinking we're going to do this, that and that. And then they realised that they didn't have actually the capacity to do it in terms of time and people... So the AKI work is not just one on its own, there are a lot more [quality improvement] projects ongoing already. And they just feel like they don't have time to do any... and they have to look after patients really. (Manager 2—Hospital X)

A key challenge in Hospital Y was the concentration of expertise among relatively few people and

the ongoing resource dependency this created. This person-dependent approach called for the hand-over of critical information that required the nurse specialists to negotiate boundaries between specialist/generalist and nurse/doctor orientations. Although front-line staff still received alerts directly on electronic reporting systems, the specialist nurses regularly attended each ward in person in order to provide guidance and to prompt appropriate actions. Despite the importance of this face-to-face communication, there was a limit to what the specialist nurses could continue to monitor and, if needed, intervene (there being only two covering the entire hospital). This caused problems because the specialist nurses did not have sufficient time to provide continued monitoring and support across the hospital, which in turn added a further burden to ward personnel who were already struggling with understaffing.

DISCUSSION

Through an ethnographic approach, this paper set out to examine the relationship between the objectives of AKI policy, the technologies mobilised to accomplish these, and the resources available to organisations to support the change. Being mindful of the relationship between work-as-imagined and work-as-done,²⁵ our findings describe three key factors shaping this relationship:

1. The fitness for purpose of the technology:
The national algorithm resulted in both over-detection and under-detection of AKI.^{12 14} Our findings raise questions about the 'fit' of a simple algorithmic approach to the management of a diagnosis such as AKI. AKI is characterised by indeterminacy and is reliant on ongoing human interpretation and judgement. Our findings illustrate two ways technology and human resource can be coordinated to manage AKI but emphasises that there are ongoing consequences of doing so for professionals and managers.^{32 33}
2. The work of making the technology fit for practice:
The problems caused by the potential for both over-diagnosis and under-diagnosis shaped the development of two different systems. Hospital Y developed its own algorithm that eradicated under-detection and contained over-diagnosis through daily manual checking of all possible cases by the nurse specialists. This may provide a safer and more reliable approach but requires significant ongoing investment. Hospital X sought to reduce the risks of over-diagnosis and under-diagnosis through the use of automated prompts to staff via its integrated record as well as by integrating the alert into daily ward routines and providing a pharmacy review of all possible cases. As under-diagnosis is by definition a 'missed case' (ie, something to which the algorithm does not alert) the Hospital X measures represent mitigation rather than eradication.
3. The consequences of this work for ongoing planning and resource use:

Hospital Y was dependent on the continued availability of resources to support the employment of a dedicated AKI nurse specialist team. This was being challenged within the time of our study, with pressures demanding their time in other areas. Hospital X faced challenges retaining engagement throughout the collaborative programme, and this looked set to be exacerbated by the launching of new improvement programmes. Resonating with previous CDSS research, which highlights the need for ongoing resources,²⁰ these factors put the sustainability of any changes in question.

Together these factors point to a key challenge associated with the attempt to maximise the utility of AKI as a driver for safe and effective care while minimising additional burden for patients and healthcare staff. Additional work represents a cost in terms of time and a reallocation of resources from elsewhere, and this complicates the ongoing task of prioritisation by hospital leaders. This undermines the persistent assumption of 'resource neutrality'³⁴ embedded in improvement methodologies and actioned through policy. Some of this resource cost was made visible through the design and delivery of the improvement programmes in each hospital. For example, in Hospital Y, the decision was taken to trade an increased rate of over-detection for eradication of under-detection. Hospital X faced a trade-off between the greater reliability that might have come from making the care bundle mandatory through the electronic record and the bureaucratic burden that they feared by doing this. This last point illustrates a broader concern with the introduction of new technology involving trade-offs between efficacy and sustainability.³⁵

Other problems became visible to the research team as unintended consequences associated with either the technology or the work undertaken to incorporate it into routine practice. A key example was the issue of 'alert fatigue',^{31 36 37} which was observed in our study when junior doctors ignored the many 'pop-ups' they routinely received. Resonating with our findings, Kanagasundaram *et al* (2016) found that a mandated response to an AKI alert 'irritated' clinicians with limited engagement in the functionality of the CDSS.³⁶ Their evaluation indicated that staff found ways to bypass alerts, which 'simply hid it until the next time a patient's chart was accessed'. Furthermore, credibility of the CDSS could be 'strained' when the detection was deemed to be too sensitive.³⁶

There are known issues regarding the accuracy of CDSSs which can create organisational problems in the additional work required to adapt to and resolve issues created by the technology in use.^{20 35} The problem of alert fatigue demonstrates that technologies can alter clinical work in a manner not always well received by clinicians.³⁸ Therefore we find a tension here between algorithmic and clinician judgements, in which there are both sanctioned and unsanctioned instances of clinicians overriding the system, respectively, to resolve

inaccuracies, or through fatigued failure to act. We draw attention to two organisational problems that result: first, if a CDSS prompts both sanctioned and unsanctioned activities on the part of professionals, then this complicates the formal organisation of work and the ability to create an auditable account of that work. Second, if errors occur as a result of the inaccuracies of a CDSS, then the question of how to reconstruct a process of care with clearly demarcated domains of responsibility becomes problematic. Within the concept of alert fatigue we therefore find a significant challenge to the maintenance of safe and transparent standards.

Focusing on 'work as done' helps to make the various workarounds associated with successive changes to systems visible and suggests that a dysfunctional effect might result from the accumulated adaptations necessary to embed changes into working routines.³⁹ Both Hospital X and Hospital Y raised concerns about the shifting of resources and priorities towards new areas of improvement prior to the completion of their programmes of work focused on the AKI CDSS. Beneath the rhetoric of the 'improvement culture' talked about in Hospital X we found evidence of 'improvement fatigue' as the demands of multiple consecutive programmes of improvement created challenges for QI managers engaging staff, and compounded existing staffing pressures. This is of particular concern if new programmes result in the adoption of practices which conflict with those adopted as part of a previous programme, as this will ultimately put in question the sustainability of any changes. If adaptations to technologies complicate the formal organisation of responsibilities in the provision of safe and transparent care, then this presents a sustainability challenge which is systemic in nature. Further research is required concerning the possible displacement of responsibility caused by the introduction of computerised decision support systems.

The study had limitations related to its ethnographic design, which permitted us in-depth but partial access to the two sites. Our access was granted via the QI team, which meant that accessing staff who were unsupportive of the QI work, or unaware or critical of AKI was more difficult. The two hospitals were at different points in their improvement programmes, and the degree of access permitted in Hospital X was greater than in Hospital Y, therefore the findings cannot be treated as strictly comparative.

CONCLUSIONS

AKI is a clinical syndrome that is of relevance to a range of patients and across all clinical settings. As such, examining AKI-related work provides an important exemplar for the implementation of system-wide CDSSs.²² Our findings contribute to a growing literature surrounding CDSSs in which there is a recognised need to 'go beyond' usability testing by broadening the evidence base to take into account the social, cultural and institutional

influences that impact adoption of CDSSs.^{39 40} Often, the introduction of something new into a complex system initiates a process of adaptations and trade-offs, referred to as 'workarounds'.^{23 41} Our findings show that such workarounds (which include the decision to ignore alerts altogether) complicate the formal organisation of care, which requires clear demarcations of responsibility. As the implementation of CDSS is increasing rapidly, our findings suggest that attention is required to the work required to make CDSS work-in-practice, and the actions and opinions of key stakeholders with regards to its use. Given the difficulty of making an automated technology visible to human intervention, the increasing use of CDSS requires a re-examination of the formal standards for making work accountable.

Acknowledgements The authors thank the participants who took part in the study. The authors also thank Professor Ruth Boaden and Peter Mellor for their contribution.

Contributors SB, AB, SH and TB designed the study. SB and AB led the data collection and analysis. SB, CH and TB drafted the manuscript. SB, CH, AB, SH, LS and TB contributed to the results interpretation, provided further inputs and edited extensively before finalisation. All authors read and approved the final manuscript.

Funding This project was funded by the National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care (NIHR CLAHRC) Greater Manchester. The NIHR CLAHRC Greater Manchester is a partnership between providers and commissioners from the NHS, industry and the third sector, as well as clinical and research staff from the University of Manchester.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available.

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