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Adoption by clinicians of electronic order communications in NHS secondary care: a descriptive account

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ABSTRACT

Background Due to the rapid advancement in information technology, changes to communication modalities are increasingly implemented in healthcare. One such modality is Computerised Provider Order Entry (CPOE) systems which replace paper, verbal or telephone orders with electronic booking of requests. We aimed to understand the uptake, and user acceptability, of CPOE in a large National Health Service hospital system.

Methods This retrospective single-centre study investigates the longitudinal uptake of communications through the Prescribing, Information and Communication System (PICS). The development and configuration of PICS are led by the doctors, nurses and allied health professionals that use it and requests for CPOE driven by clinical need have been described.

Records of every request (imaging, specialty review, procedure, laboratory) made through PICS were collected between October 2008 and July 2019 and resulting counts were presented. An estimate of the proportion of completed requests made through the system has been provided for three example requests. User surveys were completed.

Results In the first 6 months of implementation, a total of 832 new request types (imaging types and specialty referrals) were added to the system. Subsequently, an average of 6.6 new request types were added monthly. In total, 8 035 132 orders were requested through PICS. In three example request types (imaging, endoscopy and full blood count), increases in the proportion of requests being made via PICS were seen. User feedback at 6 months reported improved communications using the electronic system.

Conclusion CPOE was popular, rapidly adopted and diversified across specialties encompassing wide-ranging requests.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Computerised Provider Order Entry (CPOE) systems replace traditional methods of paper, verbal and telephone orders.
⇒ CPOE has an impact on the quality and safety of patient care and improves efficiency and clarity.
⇒ There is some controversy over whether CPOE works well in practice in improving patient outcomes and clinician satisfaction.

WHAT THIS STUDY ADDS

⇒ This study describes the implementation and adoption of electronic orders within an in-house built clinically led CPOE system in a large National Health Service foundation trust.
⇒ We have studied the changes within the system over time.
⇒ It is important that CPOE systems are carefully implemented, accepted and embedded into normal clinical activity.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ CPOE systems aid interprofessional communications, but all members of the clinical team need to fully understand the problem and work relationships.
⇒ CPOEs provide a 24-hour service, which improves order request accessibility, but more work is needed to understand potential overuse of requests.

INTRODUCTION

Communication within secondary care is vitally important to ensure safe and high-quality care for hospitalised patients. Communication technologies (including order entry systems, email, pagers and mobile phones), as components of health information technology (HIT), enable the effective and efficient communication within and between healthcare professionals, and also out to diagnostic, therapeutic and other ancillary services within hospitals. As the use of HIT advances, such communication modalities play an ever-increasing part in the healthcare system.

Computerised Provider Order Entry (CPOE) systems are electronic systems that enable healthcare providers to initiate requests for medical procedures, prescriptions and increasingly investigations and consultations, into a computer system to transmit the order to where it is required (eg, direct to the pharmacy for prescriptions).

Such systems replace the traditional order methods of paper, verbal or telephone.

CPOE on its own potentially has an impact on the quality and safety of patient care[1] as it can ensure legibility and completeness of orders and improve hospital workflow efficiency. It may also reduce the number of staff-facilitated steps required in the request pathway.[2] Despite these obvious advantages, there is some controversy over whether CPOE in practice translates into improved patient outcomes and clinician satisfaction.[3] While there is some evidence that adoption of such systems results in doctors spending greater time with both their patients and peers, over time it has become apparent that CPOE systems which introduce burdensome clerical tasks may be linked to clinician burnout.[4] It is therefore important that CPOE systems are carefully implemented to facilitate communication, without requiring unnecessary clerical steps by having clinical input into the design.[5 6] They must also be accepted and embedded into normal clinical activity, but with clear alternatives in case of system downtime.[7 8]

The majority of the literature published about CPOE focusses on prescribing requests, with limited papers on laboratory and radiological ordering often within one setting such as emergency departments or intensive care units.[9–13] Much of the literature comes from North America where orders are often connected with billing, which is not needed in the NHS setting.[14] The UK has lagged behind the international community in developing and implementing CPOE, but CPOE usage is now increasing across the UK.[15–18]

Our aim is to audit uptake of electronic orders over time for diagnostic, therapeutic and support services within the clinically led CPOE system known as the Prescribing, Information and Communication System (PICS) at University Hospitals Birmingham NHS Foundation Trust (UHB). To our knowledge, this is the first study looking at uptake of an ordering system hospital wide within the NHS.

METHODS

Setting and study population

At the time of the study (October 2008–July 2019), UHB, a large NHS Foundation Trust in the UK had approximately 1200 inpatient beds. UHB offers secondary care to local patients, as well as tertiary care across a wide variety of specialties. PICS was implemented throughout all inpatient beds, except for operating theatres. A key feature of the system is that it provides not only electronic prescription orders, but a wide variety of order requests including specialist consultations, imaging and other diagnostic and therapeutic procedure requests. The system is developed and maintained by the trust and is locally configured and updated regularly by a committee of medical, nursing and allied health professional staff.[19 20]

Implementation

A subset of imaging requests were first made available in PICS, shortly followed by the ability to refer to occupational therapists, speech and language therapists and gastrointestinal physiology. The imaging requests were tested by a small cohort of doctors in October 2008, prior to being made available to one specialty and later rolled-out hospital wide. Subsequent rollouts were made available to the entire hospital or single specialties as requested, except for laboratory order communications which were rolled-out ward by ward. System users are made aware of large changes to the system prior to deployment and informed of any restrictions, for example, only doctors being able to request imaging.

The clinical systems are built by programmers employed directly by UHB. Nurses work as business analysts (BAs) creating a link between the users and the programmers building the systems. As the systems are rolled out, trainers (also nurses) deploy face-to-face training and provide post go-live support, as well as creating user guides located on the Trust intranet. Issues can be fed back to both trainers and BAs, including updates and changes which then go through the change process for PICS. Post go-live any requests to update PICS, including suggestions to remove redundant or problematic request types, can be logged into the change process by any clinical user via the IT Helpdesk. Users therefore had the benefit of expert help at rollout and could directly feed back, influence and realise change within the system in user-led design.

Data capture and permissions

PICS has a comprehensive time-stamped auditable database of all actions taken within the system. Each user has a personalised log-in, allowing any action on any patient record to be tracked. Permission to perform this evaluation was obtained from the Clinical Governance Support Unit of UHB, which deemed this study to be service evaluation not requiring research ethics committee approval (CARMS-15901). No patient or user-level data were revealed to the team.

Requests are a separate category of procedure within the auditable database; we requested data on request category (eg, imaging, procedure or specialty review), request type, request subcategory and date and time the request was made. Data were collected from October 2008 (when order communications were first added) until July 2019. This study was undertaken prior to COVID-19 pandemic during which there was difference in the usage of electronic health records.

Orders can still be made on paper or within the system. We investigated three use cases: imaging, upper gastrointestinal endoscopies and full blood counts (FBCs), as examples of an imaging, procedure and laboratory request. We were unable to look at example of referrals to specialities as there is no way to document numbers of specialty referrals; prior to electronic referrals, these were done via bleeps or telephone and not audited. All imaging reports between 2017 and 2019 were extracted

as we could easily see which imaging requests were made via PICS during this period using a unique identifier between requested and reported imaging. A count per month of all endoscopies undertaken within the hospital was extracted and compared with the number of PICS requests. All results of FBCs undertaken after a ward went live with the ordering capability in PICS were extracted, along with date of test completion and specialty the patient was under at the time. These FBC results were then linked to the requests to determine the proportion of requests made via PICs, again using a unique identifier within the system.

As part of an evaluation of PICS after it had recently been introduced into new areas, clinical users were asked to complete a questionnaire based on the University of Iowa post go-live perceptions survey.[21] Specifically, users were asked whether they thought communication between hospital staff and legibility and clarity of patient care orders had worsened (−3 to −2, −1), stayed the same (0) or improved[1–3] since PICS' introduction. An online version of the survey was created, and links were sent out to relevant staff email lists; paper copies were also distributed at staff meetings and on wards with a return box being used to ensure confidentiality and anonymity.

This study meets four out of the five CODE-EHR (coded electronic health record framework: how and why coding was performed; the process of constructing and linking datasets; clear definitions of both diseases and outcomes; the approach to analysis, including any computational methods; and showing good data governance) framework minimum standards, with one standard not being applicable.[22]

Analysis

We recorded when each new request type was added and the calculated the number of new request types per month. The total number of requests generated in each month was also calculated from the data. To calculate the trend in the numbers of requests over time, a linear regression model was produced, with the number of requests made as the dependent variable, and the month of study as the only independent variable. The first month was excluded from this analysis. P values of <0.05 were deemed significant and statistical analyses were undertaken using R V.4.1.1 (R Core Team, 2021).

RESULTS

Between October 2008 and July 2019, a total of 8 035 132 orders were requested in PICS. The majority of the requests were related to laboratory requests after being introduced in January 2016, representing 49% of requests. Prior to this, the most common request type was imaging, representing almost 90% of requests made. Other request types were grouped into requests for procedures (such as endoscopy, renal biopsy); requests for outpatient team referral (such as anticoagulation team clinic appointment); requests for reviews by allied health professionals, medical specialties, support teams, nurse specialists (such as diabetes nurse) and other services (such as chaplaincy visits, or medical photography).

In October 2008, there were 332 request types available in PICS. This increased rapidly, almost doubling within a month (n=629). An average of 38.3 request types were added monthly, reaching 832 by March 2009 (figure 1). From this point forwards, there was an incremental increase in the number of request types in the system. The outliers were March 2012, January 2016 and February 2016 with 68, 119 and 82 new request types added.

The number of requests made per month also increased over time (figure 2). In the first representative month of the study (November 2008), 18 499 requests were made. This rate increased by a monthly average of 290 (95% CI 273 to 306, linear regression), reaching 42 672 by December 2015. This was followed by a big jump when the laboratory requests were added to the system in January 2016, with 80 367 requests made in February 2016. The rate thereafter increased by an average of 2560 (95% CI 2330 to 2791, linear regression) requests per month reaching 175 906 in July 2019.

Laboratory and imaging requests represented the majority of requests by July 2019 (49% laboratory/42% imaging, table 1). All other request types also increased steadily over time, except 'handover' which was superseded by new functionality in the EHR, and outpatient referrals which remained low (figure 3).

Between 2017 and 2019, 442 597 CT, X-ray and ultrasound reports were completed, excluding those requested by General Practioners or within the emergency department, of these 91.7% (405 918) were requested via PICS. Critical care had the highest proportion of requests being made via PICS with 99.1% (6606/6669), and medicine had the lowest proportion with 86.0% (98 585/114 685). The proportion of endoscopies requested via PICS increased at a slower rate, the proportion remained at around 40% between 2011 and 2014 before rising to 80% in 2018. There was a steady increase in the proportion of FBCs requested via PICS rising from 64.7% in 2017 to 78.5% in 2019. Critical care was again the specialty with the largest proportion of requests being made via PICS at 90.8% (47 170/51 930), and oncology had the lowest proportion at 67.2% (8678/12 905).

In the post rollout survey, 58.3% (14/24) of doctors surveyed in the first 6 months post go-live said PICS had improved communications between staff and 66.7% said the system had improved legibility of care orders; this increased to 85.2% and 88.9%, respectively, in the 27 doctors surveyed more than 6 months post rollout. Similar increases were seen in the results of nursing staff with 42.9% (9/21) surveyed within the first 6 months of PICS rollout agreed that there was both improvement in communication between staff and in legibility of care orders; this rose to 77.6% and 81.6%, respectively, in the 49 respondents answering more than 6 months post rollout.

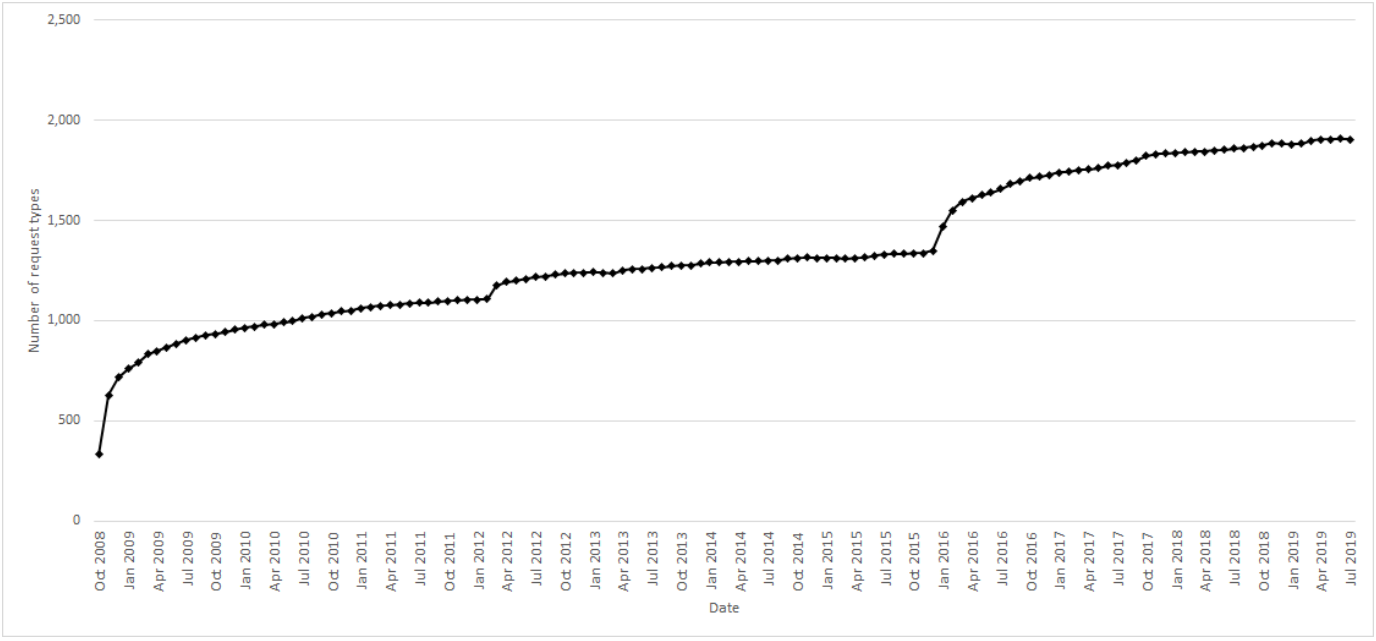

Figure 1 The cumulative number of request types on the system by month. This figure shows how many request types were available in Prescribing, Information and Communication System (PICS) per month. Increases in the number of requests can be seen at two time points after 2008: March 2012 and January–February 2016. In March 2012, a large number of imaging requests were added to the system in order to prepare for the introduction of a new imaging system, and in 2016 laboratory requests not previously available were added.

DISCUSSION

Principal findings

This study demonstrates an evolution in a clinically directed system and is likely to demonstrate what is important to clinical teams working on the front line of a busy NHS hospital. The increase in the number of requests being made over time reflects the development of systems that ease the requesting process and may also reflect a change of culture in the hospital/overall acceptance of staff to the new method, facilitated by in-hospital training. This observation is made in the context of clinician choice—electronic ordering was not mandated, and clinicians could continue to use paper or telephone/bleep systems and staff appeared to feel that it was useful from the survey results. Despite this choice, uptake was rapid and demand for more referral types via the system

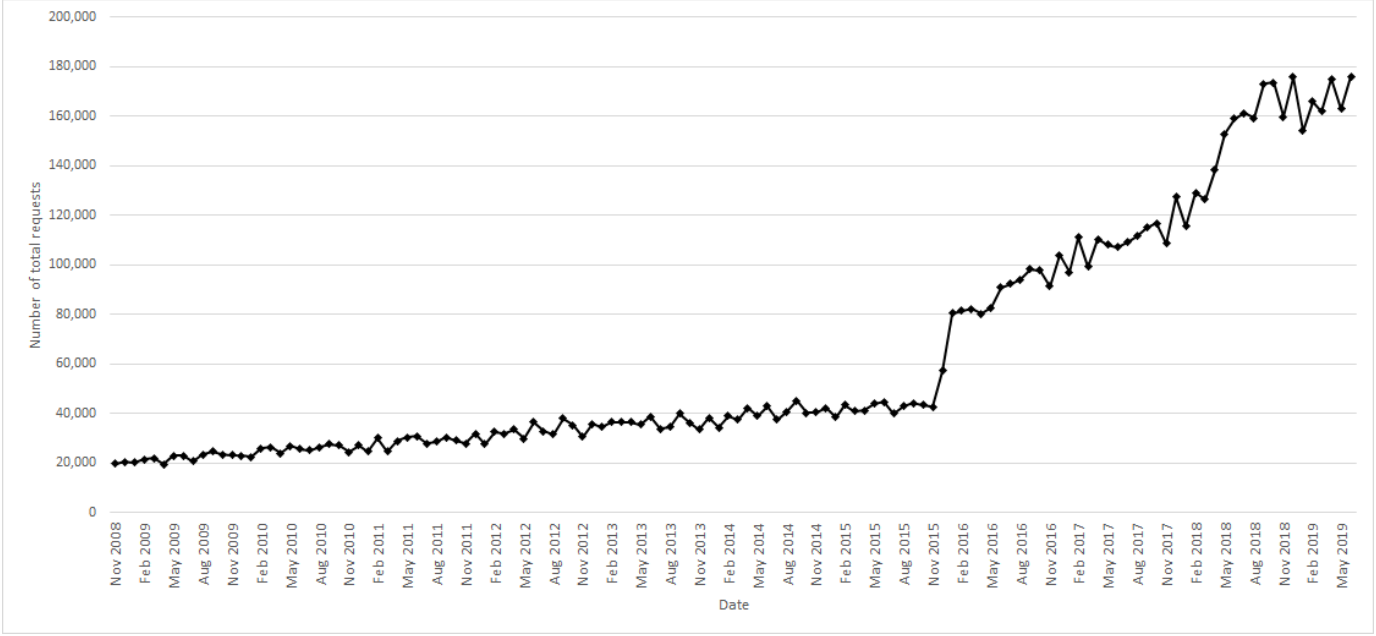

Figure 2 The total numbers of requests made per month. This figure shows the number of requests made per month during the study period. The large spike in January–February 2016 indicates when laboratory requests were added to the system.

Table 1 Frequencies and percentages of request types over the study period

Row labels	% of total	Number of requests
Laboratories	49.12	3947021
Imaging	41.86	3363135
Allied Heath Professional review	3.12	250301
Procedures	1.92	154474
Medical specialty review	1.88	151219
Support team review	0.85	68428
Nurse specialists review	0.62	50168
Other services	0.30	24465
Handover	0.30	23869
Outpatient team referral	0.03	2052
Total		8035132

This table shows the total number of requests made over the study period. Although only introduced in early 2016, the laboratory requests account for the majority of requests.

increased quickly. Clinicians could, and did, request referrals for their specialities. Imaging requesting was popular both with clinicians themselves (as it was now clear what had been ordered, how far along the process the order was and the referral was quick to do) but also with the imaging department, as the radiology system integration allowed electronic orders to appear immediately in the reciprocal system. The order forms are designed by the users. Cardiologists ask for cardiology-specific questions to be included in the referral to their service, anticoagulation nurse outpatient teams can ask for target drug levels in theirs and non-clinical requests such as chaplaincy review were also added. For clinical staff asking for imaging, blood tests, procedures such as endoscopy or specialist review, there is no need to wait on engaged phone lines, or for bleeps to be answered. For services receiving orders, workload is clear and resource allocation can be planned more easily.

There are some published advantages in computerised ordering[18]; in laboratory blood test ordering, electronic orders significantly and sustainably improved the quality of clinical information included. This resulted in changes to patient management that would not otherwise have occurred.

The steadily increasing trend was demonstrated in the volume of requests processed by PICS (from 18499 in November 2008 to 175906 in July 2019), as more processes and practices took on CPOE within the organisation. Towards the latter parts of the investigative

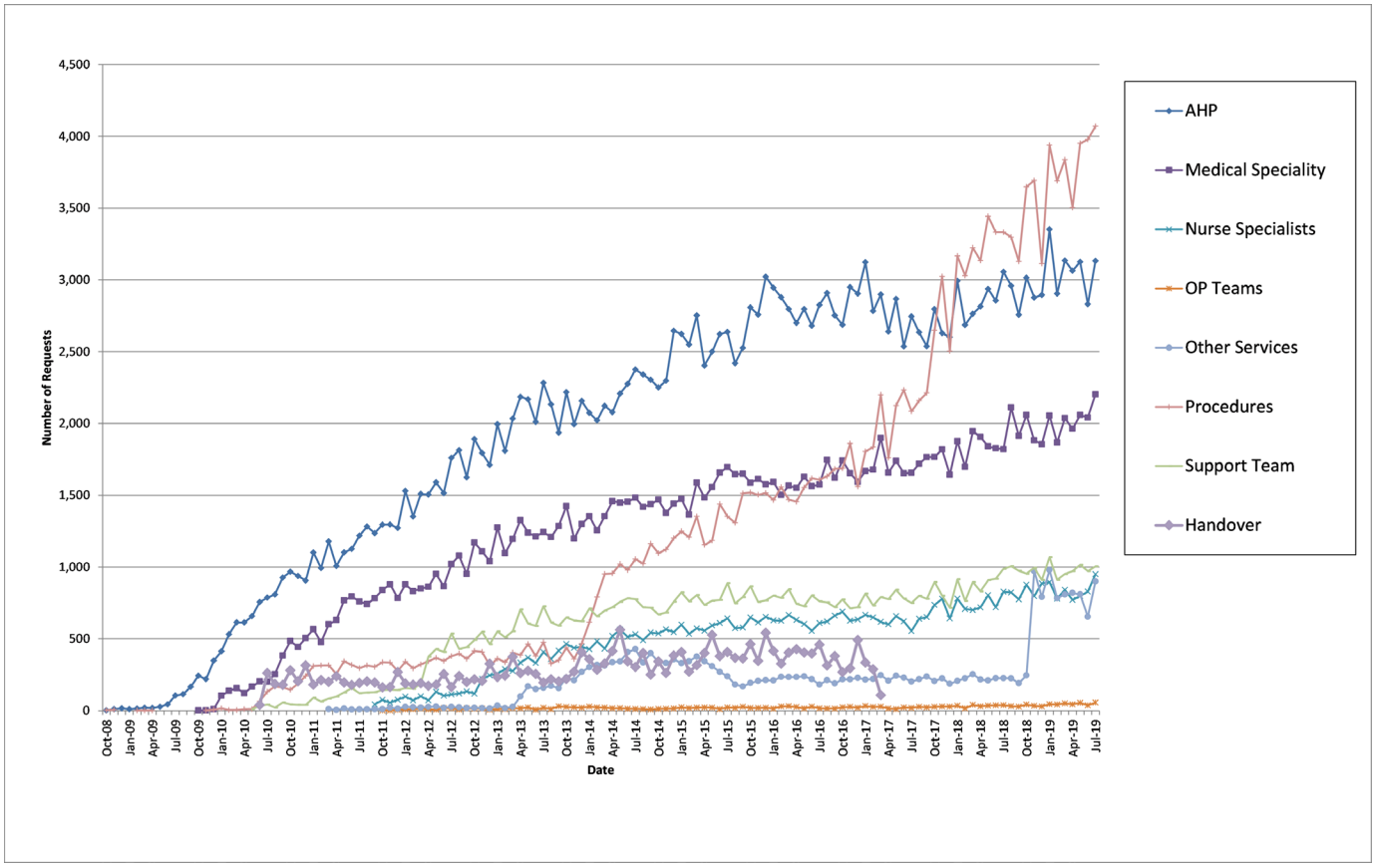

Figure 3 Requests (non-imaging/non-laboratory) by request type. This figure shows the number of requests made by request type. The imaging and laboratory requests are not shown on this figure as these are a magnitude of 10–100 times larger than the other requests.

timeframe, consultation requests for outpatient teams, nurse specialists, support teams and medical specialities plateaued, though other elements, such as procedures, have a much sharper increase in growth over our period of study. This rise in procedures is in part due to the introduction of QEHB@Home referrals, where patients complete the course of antibiotic medications in their home environment instead of prolonged hospital in-patient stays. A similar, but not as extensive rise can also be seen in other services, attributable to a greater use of lung function and the haematology/oncology day unit referral requests.

Interpretation within the context of the wider literature

Communication technologies within hospitals have traditionally relied on relatively simple devices such as pagers and faxes. In particular, much of the communication for consultations and therapeutic or diagnostic procedures traditionally relied on written request forms which had to be completed and then manually transported to the relevant department. CPOE and task management systems have revolutionised healthcare professional workflow[23 24] as completed orders can be transmitted anywhere in the hospital at the click of a button.

Traceability of information when using CPOE systems ('technovigilance') provides benefits to patients in the form of minimised missed care opportunities, validation of requests[25] and reduction of errors made due to illegibility.[26] The collection of electronic data can be used to create quality indicators[27] and further innovation strategies directed towards management of everyday actions, helping to develop the services provided to patients.

Top-down implementation of EHR including CPOE systems struggled in the UK with the National Programme for IT[14] and mistrust by doctors was cited as a factor, driven by poor end-user engagement. Interoperability and future EHR development need to consider system usability and user-centred design as reported by Chief clinical Information Officers in England.[16] Safe systems also require organisational learning to understand the impact of new developments and clear processes to amend or remove changes if needed.[28]

Implications for policy, practice and research

CPOE can effectively replace the requirement for telephone communication between healthcare professions while improving legibility of requests. PICS provides a closed loop of communication otherwise unavailable. It is important however to realise that the availability of CPOE systems is not a panacea for interprofessional communication, as one also needs to consider that good communication requires a shared understanding and clear work relationships, not just access to IT-enabled communication systems. PICS is a 24-hour service which improves order request accessibility. This ease of access however may lead to overuse of request submissions, over-dependence on the system or a reduction in post-request monitoring.[29] Our study has only investigated the growth and use of order entry communications and we recognise that there are complex sociotechnical issues at play within healthcare provider communication.[30]

Strengths and limitations

There are limitations to the conclusions that can be drawn from the data. It is possible that during the evaluation period, request types may have changed name, been split or aggregated. This risk is largely mitigated due to the large quantity of data points gathered. Any requests that were made on paper tended to be included in the clinical noting of the EHR, where, although searchable are not easily audited. The proportion of completed requests does not include rejected or cancelled requests.

Our study was not undertaken, as a prospective evaluation, but rather takes retrospective data on the use of the order entry system; however, it does represent a naturalistic view of the diversity and requirement for requesting services. Given the time period of the study, there were many policy changes related to EHR development in the NHS, being led centrally, locally and by specialty colleges[15 31]; these will have impacted the inclusion and exclusion and rule sets on requests, but have not been explored in detail.

We have studied the temporal changes within the system by month. Temporal changes do also take place at a microlevel. PICS may have positively changed the workflow to be more efficient. We have not undertaken a formal time and motion study evaluating healthcare professionals' work.[32]

CONCLUSION

Well-placed and specifically developed CPOEs are becoming an integral form of communication in acute hospitals such as our own. A large number of departments and specialities have adopted this technology, creating many opportunities for further development of the systems in place, increased audit/traceability, and subsequently, improved patient care.

In just over 10 years, UHB has progressed from entirely paper orders to nearly entirely electronic orders. Since this is a clinical-driven change, and involves clinician choice, we conclude that this has translated into clinicians using the system. Future work via time and motion studies could confirm if this improves efficiency and clarity, and if it consequently improves patient care.

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