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WHITEPAPER: THE ROLE, BENEFITS AND VALUE OF ELECTRONIC CLINICAL DECISION SUPPORT.

The Role, Benefits and Value of Electronic Clinical Decision Support in Secondary Care Electronic Prescribing.

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Many recent initiatives in the management of healthcare have focussed on the cost effective provision of care and relevant outcome measures. However, there is now an increasing emphasis on the safety of the patient when they are in receipt of this care. Indeed, patient safety is now the top priority within healthcare (1) indicating that unexpected adverse outcomes within healthcare require closer management and scrutiny in the future.

The Audit Commission report A Spoonful of Sugar, Dec 2001 (2) stated that: "…most medication errors are caused by the prescriber not having immediate access to accurate information about either the medicine (indications, contraindications, interactions, therapeutic dose, or side effects) or the patient (allergies, other medical conditions, or the latest laboratory results)… Computerised prescribing linked with electronic health records will radically alter the way in which care is provided and will deliver significant improvements in the quality of patient care."

BACKGROUND TO MEDICATION ERRORS

Medication errors were the third most common category of patient safety incidents reported to the UK's National Patient Safety Agency (NPSA) National Reporting and Learning System (NRLS) between April 2007 and March 2008, accounting for 8.8% of the total 796,142 incidents reported (3). The most common type of incident reported was patient accident (34.1%), followed by treatment/ procedure (9.8%). Medication errors were more commonly reported than incidents involving access/ admission/transfer/discharge (7.3%), infrastructure (6.7%), documentation (5.1%), or clinical assessment (4.5%).

A previous NPSA report of medication safety incidents in the NHS, Safety in Doses (2007), cited recent studies suggesting that up to 6.5% of all patients admitted to hospital and up to 9% of all patients staying in hospital experience medication related harm and that many of these incidents are preventable (4). From this evidence, the preventable harm from medicines could be costing more than £750 million each year in England (4). The report also referred to literature suggesting that up to one in ten medicines prescribed, dispensed and administered may result in error and in some cases, such as injectable medicines, this rate is much higher (4).

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Medication errors may occur at any stage of the medicines management process i.e. prescribing, administration, transcribing, dispensing, monitoring or discontinuing one or more medications. The prescribing process is complex and prone to error; 10U can be interpreted as 100 units, or 6 IU as 61 units instead of 6 international units because of inappropriate abbreviation. Patients may be overdosed with a standard release drug when a modified release formulation was intended but not specified (5). Patients may be given drugs they are allergic to, or that are contraindicated, or have already been prescribed under another name. One drug may interact with another; or the dosage, duration, formulation or route may be incorrect (6).

Nearly half of medication errors have been found to result from the fact that clinicians have insufficient information about the patient and the drug readily accessible at the time it is needed (7). Denekamp states that "with increasing knowledge, and the rapid development of an increasing range of possible treatments, clinicians routinely practice in a state of incomplete information about the patient and about medical knowledge pertaining to patients' care" (8). Meanwhile, there is a rising tide of information available for clinical decision making; the amount of biomedical knowledge has been estimated to double every 20 years (9). Many would argue that medical practitioners are not able to keep up-to-date with best practice without some assistance in their decision making.

There is evidence that healthcare delivered in industrialised nations often falls short of optimal evidence based care (10). To address this, healthcare organisations are turning to clinical decision support (CDS) systems which provide clinicians with patient-specific assessments or recommendations that assist clinical decision making (11).

DEFINITION AND OBJECTIVES OF CLINICAL DECISION SUPPORT

The definition of CDS is evolving. A full and descriptive definition of the functionality offered by CDS was presented by the US Joint Clinical Decision Support Workgroup; "providing clinicians or patients with clinical knowledge and patient-related information, intelligently filtered and presented at appropriate times, to enhance patient care" (12).

In more simple and practical terms, the National Institute for Health and Clinical Excellence (NICE) has defined CDS as an active knowledge system using two or more items of patient data to generate patient specific advice or interpretation (13). A wider concept of CDS is anything that stops bad decisions being enacted or improves the quality of decisions made (14).

In England, NHS Connecting for Health defines electronic prescribing as: "...the utilisation of electronic systems to facilitate and enhance the communication of a prescription, aiding the choice, administration or supply of a medicine through decision support and providing a robust audit trail for the entire medicines use process" (15).

In the US, separate terms "Computerised Physician Order Entry" (CPOE) and "Clinical Decision Support Systems" (CDSS or CDS system) are used. More recently, some American studies have used the term Clinical Decision Support (CDS) in Electronic Prescribing Systems (e-RX or e-prescribing) which separates prescribing from other physician or clinician orders (12).

For the purposes of this paper, the terms e-prescribing and CDS will be used to describe electronic prescribing and clinical decision support systems respectively. The objective of CDS embedded in e-prescribing systems is to improve the quality of patient care by enabling safer practice. The emphasis is on supporting clinicians in their clinical decision making, rather than making the decisions for them. Where systems are in place, users need to have good working knowledge about what is, and is not, available and be provided with training and support in order to optimise the benefit for patients.

CDS may consist of "active alerts" and "passive information" (16, 17). Within the prescribing process a pre-defined set of circumstances, determined by the integration of drug and patient information, can trigger an active alert. This may be presented in a new screen displaying relevant clinical information, such as a drug interaction with existing medication in the patient's profile.

Passive or referential information may be available to the clinician from anywhere in the system but it does not interrupt the clinician's workflow. Although clinicians may be prompted that certain information exists, they have the option to access it if they choose and may continue with their workflow without viewing this information (18).

"…much of the value of implementing an e-prescribing system is provided by the embedded clinical decision support."

Some authors have categorised active CDS into two stages; basic and advanced (12, 18). Basic CDS includes drug allergy checking, basic dosing guidance, formulary decision support, duplicate therapy checking and drug interaction checking. Advanced CDS includes dosing support for renal insufficiency and elderly patients, guidance for medication related laboratory testing, drug-disease contraindication checking and drug-pregnancy checking (18).

CDS also consists of synchronous and asynchronous events and processes. A synchronous event, e.g. dose checking, occurs as part of the prescription entry process, while an asynchronous process, e.g. a request for a report, may occur well after the initial event (16).

From the e-prescribing experience in the US and the UK to date, evidence is increasing that appropriate application of Information Technology (IT), including e-prescribing and computerised CDS with real-time alerting, can reduce error (5). There is evidence that the introduction of e-prescribing, CDS and computerised medication administration records reduces medication errors (5, 19). It is well recognised that implementing e-prescribing alone is not enough (20) and that much of the value of implementing an e-prescribing system is provided by the embedded CDS (21, 22, and 23). Such CDS includes the use of structured prescriptions which are checked for potential problems such as drug interactions, allergies, duplicate therapy and other clinical issues before the prescription is finalised (24).

Looking further ahead, when explicit computerised protocols are driven by patient data, the patient specific output will preserve individualised treatment while standardising clinical decisions (25). The expected decrease in variation and increase in compliance with evidence-based recommendations should decrease the error rate and enhance patient safety (25).

EVIDENCE OF CLINICAL DECISION SUPPORT IN REDUCING MEDICATION ERRORS

Decision support tools can influence clinician performance and patient outcome favourably (25).

Clinical decision support systems have repeatedly demonstrated their worth when evaluated. The claims made fall into three broad categories (26):

1. Improved patient safety

   e.g. through reduced medication errors and adverse events and improved medication and test ordering.

2. Improved quality of care

   e.g. by increasing clinicians' available time for direct patient care, increased application of clinical pathways and guidelines, facilitating the use of up-to-date clinical evidence, improved clinical documentation and patient satisfaction.

3. Improved efficiency in health care delivery

   e.g. by reducing costs through faster order processing, reductions in test duplication, decreased adverse events, and changed patterns of drug prescribing favouring cheaper but equally effective generic products.

At Brigham and Women's Hospital in the US, an e-prescribing and CDS system was first introduced in 1993. An evaluation of the efficacy of CPOE and a team intervention on the prevention of serious medication errors was carried out. The rate of non-intercepted, serious medication errors decreased by 55% (27). The specific types of error were an 84% reduction in transcription errors, a 68% reduction in dispensing errors, a 59% reduction in administration errors and a 19% fall in ordering errors. Drug interaction errors fell by 40% and known allergy errors by 56%.

Kuperman et al also cite research at Brigham and Women's Hospital which demonstrates that a standard default list for medication doses and frequency led to a 55% decrease in serious dosing errors and a decrease from 2.1% to 0.6% of doses exceeding the recommended maximum dose (18).

Over 11 months in a UK teaching hospital renal unit, high level alerts led to 427 of 749 prescriptions (57%) not being completed as originally intended, in other words, the alerts were heeded (28).

On introduction of e-prescribing on a renal ward at Great Ormond Street Hospital, London, a reduction of incorrect dose errors (the most common type of medication error in paediatric patients) from 2.2% to 1.2% was found (29).

After the introduction of e-prescribing and CDS on a four ward medical unit at Montagu Hospital, Doncaster and Bassetlaw Hospitals NHS Foundation Trust, compliance with trust policy for writing prescriptions improved from 37% to 96%, compliance with trust policy for recording of drug administration rose from 65% to 100% and potential adverse drug events were reduced by 61.3% (19).

Potential adverse drug events were defined as events that had the potential to cause harm, delay recovery or result in a lack of control of symptoms.

OPTIMISING THE BENEFITS OF CLINICAL DECISION SUPPORT

For e-prescribing and CDS to be successful, a multidisciplinary approach should be taken and pharmacists need to take a proactive leadership role, as they can contribute significantly (16, 30). The successful implementation of e-prescribing and CDS should facilitate and support change (31). Healthcare organisations implementing e-prescribing and CDS must understand what classes of decision support their e-prescribing systems can support, ensure that the clinical knowledge underlying the CDS is reasonable and represent individual patient data appropriately to enhance the CDS. These issues often influence to what extent an institution will succeed with its e-prescribing implementation and achieve its desired goals (18).

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For clinical pharmacy, the introduction of e-prescribing and CDS offers huge potential and opportunity for further development. Crucially, CDS alerts, such as significant drug interactions, or prompts, for example for any baseline measurements, are provided before medication is prescribed, and more importantly, before a patient receives the first dose. This reduces the amount of time that clinical pharmacy teams often spend performing manual and repetitive tasks, such as the change management of drug charts. It also allows pharmacists to improve the prioritisation of their clinical workload; spending more time working within multidisciplinary teams, or communicating with patients. Enhanced reporting capabilities of systems allows pharmacy staff to target their ward visits even further, so that they can concentrate on the more complex issues of medicines management and examine prescribing trends much more quickly. This information can then be used to facilitate training and local customisation of the CDS, where appropriate, in order to improve risk reduction, patient safety and quality improvements (31).

Much time and effort is currently being expended in secondary care in ensuring medicines reconciliation occurs for patients as soon as possible following admission to hospital. This necessitates obtaining the most up-to-date record of which drugs the patient is taking or should be taking. This is a very time consuming process, made even worse by the number of different systems a patient record may be held in; GP system, community pharmacy system, previous hospital admission records, previous ward or nursing home; sometimes a computer record, sometimes a paper record. The impact of CDS increases as more types of data and workflow are combined together in a single system or interoperable set of systems (12).

Since the introduction of an e-prescribing and CDS system at Brigham and Women's Hospital, it has become a centre of excellence and the impact of CDS has been studied in very great detail. A number of common elements important to success have been identified (14, 17, and 20). Information system users most value systems that do not slow them down, deliver information at the time that it is needed and guide users by offering alternatives, rather than simply stopping them from doing something. The use and value of the system should be monitored to improve the alerts and identify areas for further training.

"…clinical decision support must be provided automatically as part of the normal clinician workflow and at the time and place of decision making."

Active alerts such as drug interactions, drug duplications or contraindications are presented at the point of prescribing and the clinical significance of each alert needs to be interpreted for individual patients (31). By capturing the reasons for any overrides at the point of use, further analysis will reveal if the override was justified on an individual patient basis or whether further improvements or customisation of the CDS are required, or if user training is required. Clinician acceptance rates of alerts can be improved by designing a selective set of alerts and designating only critical to high severity alerts to be interruptive to clinician workflow (24, 32). More research is needed to find the optimal balance between over and under-alerting (24).

Having the flexibility to manage the threshold for alerting is critical. When the threshold for alerting is set too low, clinicians are inundated with alerts, leading to alert fatigue and high override rates for potentially important alerts (33) but setting the threshold too high erodes safety benefits (24). Specifically, systems should suppress alerts for repeat prescribing of previously tolerated medication combinations (33). A literature review of 17 studies examining clinician response to drug safety alerts within e-prescribing and CDS systems demonstrated that clinicians overrode the alerts in 49% to 96% of cases (34). Studies on cognitive processes playing a role in overriding drug safety alerts are lacking (34).

Furthermore, an otherwise perfect e-prescribing and CDS system that is fed incorrect or ambiguous patient information from an external system can produce suboptimal results. After "passing" simulation testing, extensive clinical testing (involving real patients) should occur in carefully monitored settings (35).

The effectiveness of CDS depends not just on the way it handles patient data, but also on who uses it and under what conditions (14). The benefits of an IT system may not be generalizable across different human settings of work; the effectiveness of any given computerised system in the UK may be different from its effectiveness in the US (14). This presents difficulties, as the majority of the published evidence that exists for CDS is from studies that were conducted in the US and the conditions under which such demonstrations occurred cannot be easily replicated (35). Cautionary messages have been raised that although use of CDS may improve the quality of some aspects of care, this may be at the expense of other facets of care and that such trade-offs should be carefully assessed to ensure that a net benefit (or at least no net harm) is achieved (32, 36, 37, and 38). Unfortunately, to date there is a paucity of good quality information relating to patient outcomes with the use of CDS and further research is required in this area (11, 39).

In order to derive the most benefit from CDS it must be provided automatically as part of the normal clinician workflow and at the time and place of decision making (10, 32). When clinicians have to actively search for decision support tools and then enter (or re-enter) the clinical data required to generate output, the utility and efficiency, as well as the use of decision support, decrease (32). As most prescribers do not know that they have made an error, it follows that software must run constantly in the background to intercept slips and lapses.

"A recent review of experience of e-prescribing in UK hospitals found that, in hindsight, most would have provided more training before implementation."

Users need to understand and participate in implementation and development and receive full training and support in order to derive the greatest benefits from the system. The amount of training required should not be underestimated.

A recent review of experience of e-prescribing in UK hospitals found that, in hindsight, most would have provided more training before implementation (30).

All staff should be made aware of the potential benefits for them and their patients. For example, if medicines administration is captured in real time, CDS can be provided at the point of care, with the potential to increase patient safety by structuring actions for nurses immediately prior to a drug being administered, rather than afterwards, when it is too late.

Training should go on well beyond the implementation phase and become a permanent fixture, given the turnover of staff and system developments that will ensue.

Despite the temptation to go it alone and develop in-house CDS, full consideration needs to be made of the time and cost commitments that would be required, firstly to achieve and then maintain such content, particularly among clinical staff. A team of physicians, pharmacists, and informatics professionals developed a CDS system in Massachusetts, US, to provide prescribers with patient-specific maximum dosing recommendations based on renal function (40). The time needed to develop 94 alerts for 62 drugs was 924 hours at an estimated cost of $48,668. This was compared with $23,694 for an existing decision support add-on for renal dosing (40), indicating that large scale roll out is required to make content development cost effective.

SUMMARY

Despite the concerns around over-alerting, increased research and evidence from the US and the UK demonstrate that the benefits of e-prescribing with integrated CDS outweigh any drawbacks. CDS is a vital strand of the medicines management process, augmenting and improving selection, prescribing, administration and review of medicines to optimise the contribution that medicines make to the outcome of patient care. Implemented well, CDS has a favourable impact on clinician performance, it reduces medication errors significantly, thereby improving patient safety and care and reducing the costs of preventable harm from medicines.

In the future, more timely clinical coding and management of patient problem lists in secondary

care will allow active condition checking and the provision of alerts which are even more relevant to the individual patient. This will help to address the perceived problems caused by over-alerting. However, in order to achieve this, there will need to be improved interoperability and sharing of patient information between different systems. This will be facilitated by the gradual maturation of electronic health record systems and the emergence of standard terminologies and messaging standards for the exchange of clinical data (8). In healthcare there is no final specification. Systems must be designed to support on-going changes as lessons are learned, knowledge is updated and hospital business practices change.

Workflow plays a critical role in the success of IT systems in hospitals and primary concern should be given to ensuring that clinicians receive workflow benefits so they will engage in functionality that leads to patient benefits (41).

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New and emerging next generation CDS goes far beyond alerts. It infers possible questions and needs before they are explicitly asked. It combines background information seamlessly with tools for prompting action. It embraces order sets, guidelines (local and national), flowcharts and intelligent, integrated reference information (42).

The universal adoption of a single electronic patient record as the means of accessing and sharing patient data in the NHS is a gradual process. The holy grail of fully digital healthcare may be some way away, but there are real patients, with real health problems who need to be cared for in the meantime. Computerised CDS is available now and is already providing invaluable support to clinicians, enhancing the quality of care and improving patient safety today.

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