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Strategies to reduce insulin prescribing errors in UK hospitals: results from a national survey

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What's new?

- Strategies to improve insulin prescribing quality are needed to reduce insulin errors in hospital.

- There is a wide variation in the use of recommended strategies to help improve insulin-prescribing quality, including mandatory education of healthcare staff, self-administration and self-management policies, and prescriber support at the point of care transfer.
- The use of electronic prescribing systems is slowly increasing, but there are significant differences in the functionality of systems to optimize insulin prescribing safety.
- The presence of a specialist diabetes pharmacist is associated with the increased use of insulin prescribing safety strategies in hospital.

Abstract

Aim To describe insulin prescribing practice in National Health Service hospitals in the UK and the current use of interventions and strategies to reduce insulin prescribing errors.

Methods We sent a cross-sectional questionnaire to chief pharmacists in all National Health Service hospital trusts in the UK in January 2019. Questions concerned the use and functionality of electronic and paper systems used to prescribe subcutaneous insulin, along with features and interventions designed to reduce insulin prescribing errors.

Results Ninety-five hospital trusts responded (54%). Electronic prescribing of insulin was reported in 40% of hospitals, most of which were teaching hospitals in England. We found a wide variation in the functionality of both electronic prescribing and paper-based systems to enable the safe prescribing of insulin for inpatients. The availability of specialist diabetes pharmacists to support the safe prescribing of insulin was low (29%), but was positively associated with the use of a greater number of insulin prescribing error reduction strategies (P=0.002). The use of specific interventions to improve insulin prescribing quality (e.g. self-administration policies) varied greatly between respondent hospitals.

Conclusions There is potential to optimize the functionality of both electronic and paper-based prescribing systems to improve the safe prescribing of insulin in hospitals in the UK. The wide variation in the use of insulin error reduction strategies may be improved by the availability of specialist diabetes pharmacists who can support the implementation of insulin-prescribing interventions.

1 INTRODUCTION

Insulin is a critically important medicine for the treatment of people with type 1 diabetes and is being increasingly used in the management of type 2 diabetes [1]. Insulin is classed as a 'high-risk' medicine because of the increased potential for harm when prescribed or administered erroneously. Unfortunately, insulin errors are not uncommon, with the 2017 British National Diabetes Inpatient Audit (NaDIA) reporting that two-fifths of those treated with insulin (40% with type 1 diabetes and 37% with type 2 diabetes) experienced an insulin error whilst in hospital [2].

Prescribing insulin is complicated by its narrow therapeutic window, the variety of insulin products available, including concentrated and biosimilar insulins, similar-sounding brand names, and the varied terminology used to describe them (e.g. long-acting, human, cloudy, biphasic). Inter-individual variation in insulin doses, regimens, and lack of knowledge or experience can further obscure the prescribing process [3,4]. This may also be compounded by a culture of reluctance to contest unclear insulin prescribing [5].

The causes of prescribing errors are multifactorial, involving organizational processes and environmental conditions, as well as knowledge-based mistakes, violations, slips and lapses [6]. Interventions to improve inpatient insulin prescribing include the use of dedicated insulin prescription forms, clinician education, and readily accessible insulin prescribing guidance and protocols [7–9].

Electronic prescribing (also known as computer physician order entry) is also cited as an important prescribing safety intervention, despite conflicting evidence regarding its impact on inpatient medication errors [10]. Recommended functions of electronic prescribing systems to optimize insulin prescribing include the use of Tallman lettering, insulin order sets, decision support capabilities, appropriate alerts and the ability to prompt the use of organization-specific protocols [11,12].

In the UK, recommendations from the National Institute for Health and Care Excellence (NICE) include the use of the 'insulin passport' to record contemporaneous insulin information, and avoiding the abbreviation of units to minimize dose misinterpretation [13]. A recent report by Diabetes UK urged hospitals to support people with diabetes to self-administer and manage their insulin where appropriate, and recommended mandatory insulin safety training for all healthcare professionals caring for people with diabetes, along with rigorous and robust recording and auditing of insulin errors. Access to a fully staffed diabetes inpatient team, including specialist diabetes pharmacists to help reduce insulin errors, was also recommended [14,15].

The results of the NaDIA show considerable variation in insulin errors across hospitals [2], and the extent to which hospitals currently adhere to insulin error prevention recommendations is currently unknown. Although the uptake of electronic prescribing in the UK has increased in recent years, the functionality of electronic prescribing systems to facilitate insulin prescribing safety has not been described in detail. To address the unacceptably high numbers of inpatient insulin errors in an informed way, insulin prescribing systems and error reduction strategies in current use should be examined.

In the present study we aimed to describe current insulin prescribing practice in UK hospitals. Our aims were to conduct a cross-sectional survey of NHS hospitals to determine the

processes and systems currently used to prescribe subcutaneous insulin for inpatients with diabetes, and to describe the range and uptake of interventions currently used to reduce insulin prescribing errors and improve insulin prescribing safety.

Methods

We conducted a cross-sectional survey of National Health Service (NHS) hospitals' subcutaneous insulin prescribing systems using a self-administered postal and online questionnaire (Qualtrics XM) between January and May 2019. The questionnaire was developed according to good practice guidance [16,17] and was co-designed and piloted with academics and specialist diabetes pharmacists from three hospital trusts to enhance face validity. The final questionnaire included four sections, capturing: (A) details regarding hospital demographics, (B) functionality of electronic prescribing systems with respect to subcutaneous insulin, (C), paper prescribing of insulin, (D) strategies for insulin error reduction and (E) respondents' opinions on the effectiveness of error reduction strategies. This paper presents the findings from sections A to D, where respondents selected 'yes', 'no' or 'unsure' to the use of system functions and strategies identified from the literature, and our experience of current practice (File S1). An open question allowed respondents to describe any additional initiatives in use.

Questionnaires were sent to chief pharmacists of all UK NHS hospital trusts during January 2019. This group was presumed to have a broad knowledge of the prescribing systems used in their trust, but could delegate completion to diabetes pharmacists where appropriate. Only one response from each hospital trust was required, and concerned the main acute hospital within the trust. Non-NHS/private hospitals were excluded from the sample.

A list of all UK NHS hospital trusts and health boards was obtained from NHS webpages [18–21], giving a total of 175 trusts/health boards at the time of study. A cover letter was sent in the postal questionnaire, as well as a business-franked return envelope in order to help increase the response rate. Respondents were informed that all data would be anonymized and their responses would remain confidential. Follow-up emails with a link to an online version of the survey were sent to non-respondents after 4 weeks.

Both the multidisciplinary diabetes inpatient service improvement group and the patient public involvement group at the base NHS Trust supported the research aims, and were involved in conceptualizing the research question, designing the study and interpreting results. We emphasize the findings regarded by the patient group as particularly impactful for people with diabetes.

Data analysis

All completed postal and online questionnaires returned by 10 May 2019 were eligible for inclusion. Data from paper questionnaires were manually inputted into Microsoft Excel 2016. Online data were incorporated into the dataset, coded and exported to SPSS (IBM V24) for descriptive analysis. Data input was checked by a second researcher and a joint decision was made regarding interpretation of unclear responses.

The main outcome for analysis was a binary variable (yes/no), indicating the use of interventions and system functions relating to inpatient subcutaneous insulin prescribing. Missing and 'unsure' responses to individual items were classed as 'unknown'. Subset analysis was conducted according to the prescribing system used by hospitals (electronic/paper). Chi-squared and Fisher's exact tests were used to determine associations between sets of two categorical data, and two-tailed independent *t*-tests for equality of means were used to determine differences between categorical and continuous data. We excluded

community and 'other' hospital types from exploratory analysis because of the disproportionately smaller group sizes compared to teaching and district general hospitals. Reliability was estimated with the use of Cronbach's α. Open question data regarding local interventions were grouped according to intervention categories described by Bain *et al.* [7] and were not subject to quantitative analysis.

Ethics

University ethical approval was obtained for the study (SAS-SREIC 4.1.19-3).

Results

After excluding duplicate or incomplete responses, 95 NHS hospital trusts (54% of 175 organizations) were included in the final analysis; 55 (58%) from initial postal responses and an additional 40 (42%) after online follow-up. These included 82 hospital Trusts in England (55%), five from Wales (83%), three from Scotland (21%) and five from Northern Ireland (100%; Fig. 1).

The overall Cronbach's α value of the questionnaire was 0.92 (n = 58), indicating very good reliability. Individual item analysis showed respondents tended to answer all items. The median (range) response rate per question was 99 (84–100)%. Most respondents were from teaching hospitals (42%) or district general hospitals (40%), with between 200 and 500 (35%) or 501 and 1000 (40%) inpatient beds. Eighty-one organizations (85%) provided a specialist diabetes service, but only 28 (29%) employed a specialist diabetes pharmacist. An additional 27 organizations (28%) were able to describe a pharmacist who was overseeing diabetes care, but there was a wide range in the availability and experience of the pharmacists. A summary of the systems used when prescribing subcutaneous insulin is outlined in Fig. 2.

Electronic prescribing

Forty-six organizations (48%) used inpatient electronic prescribing, all of which were in England. Of these, 38 (83%) used electronic prescribing for subcutaneous insulin. The eight hospitals (17%) that did not prescribe insulin electronically (e.g. where insulin was documented electronically but required cross-reference to a paper prescription) were excluded from the electronic prescribing subset analysis.

We found a statistically significant association between hospital type and use of electronic prescribing, with a greater proportion of teaching hospitals using electronic prescribing than district general hospitals (63% vs 39%; $P = 0.035$), and a significantly greater proportion of teaching hospitals prescribing insulin electronically (96% vs 67%; $P = 0.003$). Only one out of five community hospitals used electronic prescribing, but not to prescribe subcutaneous insulin.

Most electronic prescribing systems included basic forcing functions, such as the mandatory selection of 'units' as the unit of dose measure (89%) and dropdown/autofill selection of available insulin products (84%). The use of other safety features varied, such as high-dose alerts (26%), concentrated insulin alerts (47%), and the ability to check doses (13%). Only 32% of electronic prescribing systems allowed the prescribing of variable doses for people who were carbohydrate-counting, 8% could not specify the insulin device used, and 37% could not associate mealtimes with a prescribed insulin dose. Less than half of electronic prescribing systems (47%) incorporated the use of insulin order sets (i.e. pre-population of prescription information). Figure 3 provides an overview of the reported functions of electronic prescribing for insulin.

Paper prescribing

Out of 57 hospitals (60%) not using electronic prescribing for prescribing subcutaneous insulin, 38 (67%) used dedicated insulin prescribing charts. These included 100% of respondents from Scotland and Northern Ireland, four out of five (80%) in Wales, and 59% in England. Thirteen out of 16 teaching hospitals that did not prescribe insulin electronically used dedicated insulin prescribing charts (81%), compared to 19 out of 28 (68%) district general hospitals. Only one out of five (20%) community hospitals used a dedicated insulin prescribing chart.

Most charts were designed to reduce prescribing errors by pre-printing 'units' on the chart (79%) and encouraged the association of doses with mealtimes (71%). Other features were less common, such as the inclusion of pre-printed devices (29%) to prompt consideration of this often-neglected element of the inpatient insulin prescription. Most charts contained a blood glucose monitoring section to aid management (76%), but fewer contained both a monitoring section and organization-specific management guidelines (45%).

Insulin prescribing error reduction interventions

A mean (SD) of 9.0 (3.1) interventions were used in hospitals to improve insulin prescribing safety, ranging from two (one medium-sized mental health teaching hospital in England) to 16 (one large teaching hospital in England). The type of hospital was not found to have a statistically significant association with the mean (SD) number of interventions used [9.5 (3.4) for teaching hospitals vs 8.9 (2.6) for district general hospitals; $P = 0.42$], but the presence of a specialist diabetes pharmacist did [10.6 (3.1) with a pharmacist vs 8.3 (3.0) without; $P = 0.002$]. Interventions used by respondents are presented according to intervention type in Fig. 4 and categorized by hospital type in Table S1. The most common interventions in use

include hypoglycaemia and hyperglycaemia guidelines to support appropriate insulin prescribing (95% and 79%, respectively) and the use of the patient's own insulin on admission to minimize product selection error (93%). There was no one single intervention that all hospital trusts were using, and only four interventions that more than half of trusts used.

The use of policies to encourage self-administration of insulin were reported by 63% of trusts, with self-management policies being less common (31%). Hospitals not included in this number were those describing the use of general medicines self-administration policies that were not insulin-specific (*n*=3) or who were currently developing insulin self-administration and self-management policies (*n*=2). Insulin self-administration policies were used in hospitals in all countries (70% of respondents in England, 40% in Wales and Northern Ireland and 33% in Scotland) and all types of hospital (68% teaching hospitals, 63% district general hospitals, 60% community hospitals and 67% other hospitals). Self-management policies were in place in hospitals in England (34%), Wales (20%) and Northern Ireland (20%) and in all types of hospital (35% teaching hospitals, 26% district general hospitals, 60% community hospitals and 25% of other hospitals).

Only 33% of organizations had policies in place to aid the safe and appropriate prescribing of biosimilar insulins, and just 33% organizations used the insulin passport. The use of prescriber support interventions, such as insulin pocket-sized guideline cards or discharge checklists, was even more uncommon. Other strategies to help reduce prescribing errors and increase the quality of insulin prescribing were described by respondents and are presented in Table 1.

Discussion

This is the first survey to focus on subcutaneous insulin prescribing system functionality and safety interventions in NHS hospitals. Our results describe the current use of a range of interventions to improve insulin prescribing safety in hospitals, and highlight potential opportunities for safety features to be incorporated in both electronic and non-electronic prescribing systems. In describing the current practice, an important context is provided for those seeking to design, develop or improve interventions to increase insulin safety.

The use of inpatient electronic prescribing systems in English hospitals seems to be increasing in line with recommendations from the NHS Long-Term Plan [22]. Our results show greater uptake of electronic prescribing in the UK than in previous studies [23,24], but progress remains slow, with more than half of organizations using a combination of both electronic prescribing and paper-based systems, potentially threatening patient safety. The volume of work required to design, implement and maintain electronic prescribing systems, as well as the introduction of new error types and requisite change in organizational behaviour and workflow may be largely responsible for this [25]. The 17% of organizations using electronic prescribing that were not prescribing insulin electronically may be attributable to the perceived, or real, lack of flexibility and functionality of electronic prescribing systems to enable adequate insulin prescribing, particularly where variable doses are needed.

Where electronic prescribing is used to prescribe insulin, the variation in system functionality reflects the wide range of different systems in current use [26], and may affect the ability of electronic prescribing to reduce insulin errors. Decisions to use clinical decision-support features (e.g. alerts) may also be influenced by perceptions of their usefulness, and are likely to be overridden if poorly timed and designed [27]. Further support for optimal electronic prescribing system design to facilitate accurate and safe prescribing of subcutaneous insulin

is therefore required if the full potential of electronic prescribing systems to reduce insulin errors is to be realized in the UK.

There is also variation in paper-based insulin prescribing, with around one-third of hospitals not using a dedicated inpatient subcutaneous insulin chart (or diabetes medication chart, chart section or insert). The use of insulin charts has been nationally promoted on account of their ability to reduce insulin prescription and management errors, to improve prescription clarity and control of hypoglycaemia, to aid the identification of insulin device and the administration of insulin, and to educate staff [8]. Despite this, it is evident that further efforts could be made to increase the use of insulin charts and optimize their design to improve insulin safety in hospital.

Overall, a wide range of strategies were used to help promote the safe and appropriate prescribing of insulin in hospital. A reassuringly high proportion of organizations had current, local guidelines in use to help manage inpatient hypoglycaemia and hyperglycaemia. The greater variation in use of other strategies may reflect the organizational and departmental support available to design, develop and implement these interventions. Our results regarding the low availability of specialist diabetes pharmacists are similar to those of the 2018 NaDIA Hospital Characteristics report (29% vs 24%), and support calls for further involvement of pharmacy teams to help improve insulin prescribing safety [24].

Mandatory insulin education for all healthcare professionals involved in prescribing and administering insulin does not appear to be widely implemented across hospital organizations, despite the increasing availability of free educational packages. Although people-focused educational interventions might be considered less effective than system-based forcing actions, studies citing low confidence and knowledge of healthcare professionals with respect to insulin use would point to the ongoing need for education and

training in this area [4,28,29]. The recently published Joint British Diabetes Societies for inpatient care guideline outlines the suggested educational content for mandatory and competency training of healthcare professionals caring for people with diabetes [30].

Interestingly, the uptake of the insulin passport, which has been recommended by NHS Improvement (formally the NPSA) since 2012, is currently used by less than one-third of hospitals, which may be due to a lack of availability and clarity on who is responsible for updating the record, low confidence in their use and usefulness, and concerns over outdated records increasing clinical risk [31,32]. The use of an electronic (mobile app) version, mentioned in Table 1, may be beneficial for certain people, particularly if these concerns are addressed accordingly.

The use of insulin self-administration and self-management policies to enable people with diabetes to self-manage safely in hospital is particularly important to support patient empowerment and prevent unnecessary harm from insulin errors. Our results showing national variation in the availability of these policies, and the low numbers using self-management policies, may require further exploration regarding problems and solutions with implementing this recommended practice. Lastly, considering the low number of organizations with insulin biosimilar policies, national support for local organizations designing and implementing insulin biosimilar policies would be recommended to enable the realization of the potential significant cost savings with the safe use of biosimilar insulins.

Although the survey was reviewed by a multidisciplinary diabetes team, and involved mainly fact-based questions that could be answered with reference to protocols or colleagues in the organization, the possibility that some responses may have been different if answered by another individual at the hospital cannot be excluded. As respondents were asked to describe current practice, recall bias is unlikely to have had an impact on the results, although non-

response bias could have affected the results. Our response rate was, however, comparable to similar surveys [33].

We did not seek to associate intervention use with insulin error rates as the diversity and complexity of organizations, systems and error measurement may present significant confounders that would threaten the ability to draw any meaningful conclusions. Further exploration regarding the design, implementation and use of insulin prescribing interventions, as well as their impact on insulin errors in individual organizations, could, however, give valuable insight into the impact of strategies to improve insulin safety in hospital. This may include the use of continuous quality improvement methods that are sensitive to local cultures and contexts [34], or theoretically informed evaluation methodologies that are able to produce translatable results that sufficiently account for contextual factors [35].

In conclusion, effective strategies to improve insulin prescribing quality are needed to reduce harmful and costly insulin errors for people with diabetes in hospital. Inpatient electronic prescribing use is increasing, but there are significant differences in the functionality of systems to optimize insulin-prescribing safety. There is a wide variation in the use of recommended strategies to help improve insulin prescribing quality, including provider education, decision support, policy, restrictive actions and team changes. Currently, there is further scope for organizations to implement recommended strategies to facilitate a reduction in insulin prescribing errors, including the appointment of specialist diabetes pharmacists, educational interventions and self-administration, self-management and biosimilar insulin polices.

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Competing interests

None declared.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

File S1. Insulin questionnaire.

Table S1. Percentage of hospitals using insulin prescribing interventions, grouped according to hospital type. *P* values have been calculated using chi-squared with Fishers exact (one-sided) tests to show differences between teaching hospitals and district general hospitals only, due to heterogeneous group sizes of other hospital types.

FIGURE 1 Geographical representativeness of respondent organizations according to postcode of hospital organization. Grey areas represent areas of non-response or where the hospital trust/health board for that area is located in a different area (e.g. 100% health boards in Northern Ireland responded but are not located in County Tyrone or Fermanagh, and hospital pharmacy services in Powys, Wales are provided by the neighbouring county's health board). Map created with mapchart.net©.

FIGURE 2 Summary of systems used to prescribe insulin in NHS Hospitals as reported by survey respondents.

FIGURE 3 Functionality of electronic prescribing (EP) systems reported by NHS hospitals using EP systems to prescribe subcutaneous insulin in the UK (*n*=38). 'Unknown' comprises responses for 'unsure', 'not applicable', and missing data.

FIGURE 4 Use of insulin prescribing interventions in UK NHS hospitals (*n*=95). Unknown' comprises responses for 'unsure', 'not applicable' and missing data.

Table 1 Insulin prescribing quality improvement interventions described by respondents

Provider education
Educational outreach to ward staff (e.g. on request or when required)
Individual insulin prescribing feedback delivered by ward pharmacist and monthly group feedback sessions
Dedicated 'Making Insulin Treatment safer (MITS)' funded project
Participation in the national insulin safety week

Lunchtime teaching sessions given to foundation doctors annually
Non-mandatory completion of insulin-specific e-learning packages
Core training for medical/nursing staff at key points (e.g. progression between foundation year training or core medical training)
Provider decision support
Insulin resource folder (e.g. containing relevant guidelines and policies)
Posters on wards (e.g. Think Glucose©, details of insulin devices, profile, dosing and administration)
Dedicated prescribing charts for diabetic ketoacidosis (DKA) and hyperosmolar hyperglycaemic state (HHS)
'Insulin equipment on discharge' sticker
Additional discharge form for patients receiving insulin from district nurses or care home
Diabetes team use the same electronic patient record system as the local primary care teams
Diabetes guideline mobile software application (mobile app)
Mobile app version of the insulin passport
Team changes
Use of 'in-reach' by community diabetic liaison nurses to support management of patients
Generalist pharmacist review of those prescribed insulin as priority using prioritization software
Specialist diabetes nurses of whom some are independent prescribers
Diabetes link nurses and diabetes champions to upskill clinical areas
Pharmacy-led insulin self-administration assessment

Identifying patients prescribed insulin at nursing handover
7-day clinical pharmacy service on inpatient wards
Policy
Insulin prescribing by brand name only
Availability of Hypo-boxes on wards
Therapeutic substitution guidelines if non-formulary insulin/device
Dispensing alerts and special medicine bags for concentrated insulins
Insulin stored in patient's lockers instead of the ward fridge
Restrictive changes
Removal of insulin cartridges from use; default use of pre-filled pens unless cartridges specified
Use of Apidra [insulin glulisine] for correction doses to reduce mix-ups between Novorapid [insulin aspart] and Novomix 30 [insulin aspart/insulin aspart protamine]
Limited number of insulin vials in every ward fridge for STAT/first doses
Audit and feedback
Think Glucose monthly audits reported to ward
Insulin-related adverse incident report forms reviewed, and trends identified (e.g. monthly)
Monthly safety/lessons learned meetings to review diabetes related incidents
Weekly lunchtime meeting involving answering insulin queries
Wireless monitoring of blood glucose levels: provides alerts to acute inpatient diabetes team when blood glucose results out of range