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Evaluation of an implemented new insulin chart to improve quality and safety of diabetes care in a large university hospital: a follow-up study

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ABSTRACT

Objectives To evaluate structure, documentation, treatment quality of a new implemented standardised insulin chart in adult medical inpatient wards at a university hospital.

Design A before–after study (3 to 5 months after implementation) was used to compare the quality of old versus new insulin charts.

Setting University Hospital Graz, Austria.

Participants Healthcare professionals (n=237) were questioned regarding structure quality of blank insulin charts.

Interventions A new standardised insulin chart was implemented and healthcare professionals were trained regarding features of this chart. Data from insulinised inpatients were evaluated regarding documentation and treatment quality of filled-in insulin charts (n=108 old insulin charts vs n=100 new insulin charts).

Main outcomes and measures The primary endpoint was documentation error for insulin administration.

Results Healthcare professionals reported an improved structure quality of the new insulin chart with a Likert type response scale increase in all nine items. Documentation errors for insulin administration (primary endpoint) occurred more often on old than new insulin charts (77% vs 5%, p<0.001). Documentation errors for insulin prescription were more frequent on old insulin charts (100% vs 42%) whereas documentation errors for insulin management rarely occurred in any group (10% vs 8%). Patients of both chart evaluation groups (age: 71±11 vs 71±12 years, 47% vs 42% women, 75% vs 87% type 2 diabetes for old vs new charts, respectively) had a mean of 4±2 good diabetes days. Overall, 26 vs 18 hypoglycaemic episodes (blood glucose (BG) <4.0 mmol/L (72 mg/dL), p=0.28), including 7 vs 2 severe hypoglycaemic episodes (BG <3.0 mmol/L (54 mg/dL), p=0.17) were documented on old versus new insulin charts.

Conclusions The implementation of a structured documentation form together with training measures for healthcare professionals led to less documentation errors and safe management of glycaemic control in hospitalised patients in a short time follow-up. A rollout at further medical wards is recommended, and sustainability in the long-term has to be demonstrated.

Strengths and limitations of this study

- A strength of the study is that improvements in documentation quality were connected with beneficial clinical outcome.
- The project was performed during regular working hours as an essential quality assurance project.
- A lesson learnt from the present work was that training of the nursing and medical staff is a real challenge in a typical hospital setting.
- When designing a new insulin chart an early review of the necessity of all fields on the new insulin chart should be done.
- It can be assumed that the more fields that need to be filled-in the less likely any of them will be charted.

INTRODUCTION

Up to 22% to 30% of hospitalised patients have diabetes and occurring hyperglycaemia and hypoglycaemia can lead to adverse outcomes and even to death.[1–4]

To reduce high blood glucose (BG) values, insulin is often considered to be the first choice in the hospital setting.[4 5] Despite good treatment effects, insulin is also listed as a high-alert medication by the Institute for Safe Medication Practices[6] because it can cause serious harm to patients when used incorrectly.[4 5 7 8]

Errors in insulin prescription and administration are common[4 5 9] and include, for example, missed or wrongly administered insulin doses, incorrect prescription of insulin name, dose or type, abbreviations in insulin prescription or illegible handwriting.[4 5 7 9–13] The UK National Patient Safety Agency reported 3881 incidents with incorrect insulin doses from 2003 to 2009. Most commonly, abbreviations in insulin prescription and errors in using insulin syringes were identified that led to harm and in some cases even to death.[9] In England and Wales, the National Diabetes Inpatient Audit (NaDIA)

determined that in 31% of inpatients a medication error and in 18% an insulin error occurred during hospital stay.[14]

In many hospital settings the main documentation tool for diabetes therapy is still a paper-based insulin chart. On this documentation sheet, insulin prescription, insulin administration, BG values, treatment for hypoglycaemia and all other relevant information should be documented.[4 5 11] The insulin chart is used by different healthcare professionals for documentation, interpretation and communication. Differences in the design of insulin charts could impact the quality of inpatient diabetes care.[11] Therefore, international guidelines recommend a standardised documentation of diabetes management[4 5 15] and efforts are undertaken to identify safe and effective insulin charts.[16] Previous studies reported improvements in inpatient diabetes care after implementation of a newly developed insulin chart.[10 17–20]

At the University Hospital Graz, a new standardised paper-based insulin chart (figure 1) was developed by an interdisciplinary project team including nurses, physicians, researchers and a quality manager due to previously identified quality

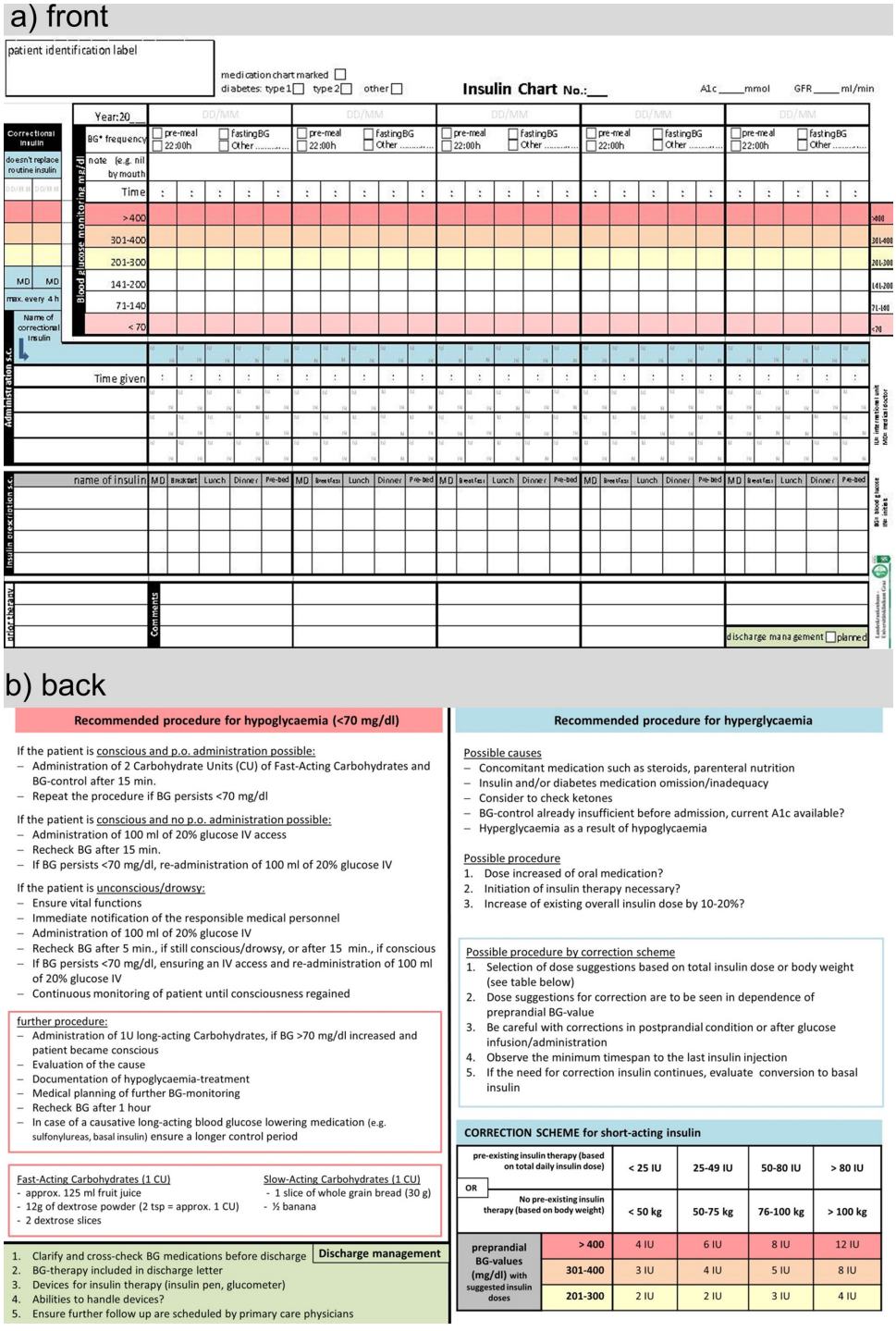

Figure 1 The newly designed standardised insulin chart. BG, blood glucose; GFR, glomerular filtration rate; h, hours; IV, intravenous; p.o., oral.

deficits (eg, missing transparency between insulin prescription and administration process, unclear patient identification, missing guidance for treatment of hypoglycaemia) as well as international and local standards.[4 5 10 11 21] In an iterative process preclinical piloting of the prototype was performed by healthcare professionals, who worked with insulin charts every day. All relevant features of the new insulin chart were discussed and feedback from healthcare professionals was integrated in the development until a consensus was found regarding design and content. The new insulin chart only relates to paper-based subcutaneous insulin prescription and comprises the following main components: patient identification, BG control, insulin prescription, insulin administration, integrated correction scheme, guidance for treatment of hypoglycaemia and hyperglycaemia. Electronic prescription systems and intravenous insulin prescription were not in the scope of this evaluation. We separated the documentation of insulin prescription and insulin administration to allow a transparent verification of clinical authorisation and notification of administration. The aim of the present investigation was to evaluate structure, documentation and treatment quality when using the newly implemented paper-based insulin chart compared with the old insulin charts in patients receiving insulin therapy in adult medical wards.

METHODS

Reporting

The research and reporting methodology was performed according the SQUIRE (Standards for Quality Improvement Reporting Excellence) 2.0 checklist.

Study design and setting

The evaluation of insulin charts was performed in nine adult medical wards at the Department of Internal Medicine at the University Hospital of Graz, Austria. At the time of this study the general wards were all using paper-based fever and insulin charts in routine patient care.

Implementation of new insulin chart

The rollout of the newly developed insulin chart (figure 1) was conducted stepwise at the nine adult medical wards on behalf of the hospital management board. In general, the organisational readiness for lean management projects and patient safety topics is assured in our hospital.[22] Therefore, the use of one standardised instead of several insulin charts was very well supported by hospital management.

Before the rollout took place in a ward, the head of the ward and the chief nurse were introduced to the new insulin chart by representatives of the developers. For the implementation, a training concept was developed by the interdisciplinary project team and training schedules were arranged together with each ward. The training regarding the use of the new insulin chart was done separately on each ward by the interdisciplinary team. Overall, 49% of physicians and nurses were trained together in group sessions during regular working hours by presenting them the main features of the new insulin chart using practical examples. Based on learning by doing, healthcare professionals themselves filled in the new insulin chart using practical examples. Further time for questions and ambiguities was provided. The training duration ranged from 45 to 60 min. The remaining healthcare professionals were trained individually or in small groups by an authorised representative on each ward, who was also responsible for implementation and available to answer any questions. Additional training material, such as a training manual, folder and poster, was generated to support the implementation process. In addition, a diabetes nurse specialist held courses regarding diabetes management with a focus on insulin therapy using the new insulin chart. All nine wards made use of this service.

Data collection

A before–after comparison regarding the quality of the old insulin charts (tested in phase 1) and the new insulin charts (tested in phase 2, 3 to 5 months after implementation of the new insulin chart) was conducted (figure 2). Overall, there had been four different old insulin charts (see online supplemental file 1) in use at the nine evaluated wards versus one new insulin chart after implementation. Regarding the four different old insulin charts, one insulin chart was used by five wards, one by two wards and the remaining two by one ward each. Blank and filled-in insulin charts were evaluated. Data on structure, documentation and treatment quality of the insulin charts were collected.

Evaluation of blank insulin charts

In a before–after comparison the subjective perception of healthcare professionals regarding structure quality of blank old insulin charts (n=4) versus blank new insulin charts was evaluated. A paper-based questionnaire was developed by the interdisciplinary team including relevant quality indicators identified in a previous study.[23] To improve face validity and content, six nurses at the Division of Endocrinology and Diabetology completed the questionnaire individually in a pilot testing. The questionnaire was adapted based on their feedback regarding content, clarity, appropriateness and design. Subsequently, physicians and nurses of all participating wards were asked to complete the adapted questionnaire by assessing the quality indicators. Each item was rated on a 4-point Likert type response scale, with the four categories ‘I disagree’, ‘I partially disagree’, ‘I partially agree’ and ‘I agree’ coded as 1 to 4.

Evaluation of filled-in insulin charts

Documentation and treatment quality were evaluated by reviewing filled-in old versus new insulin charts based on methodological elements used by the National Diabetes Inpatient Audit[24 25] and, if needed for clarification, by referring to clinical notes for further explanations.

Paper-based insulin charts from adult inpatients who were treated with insulin and who were admitted at one

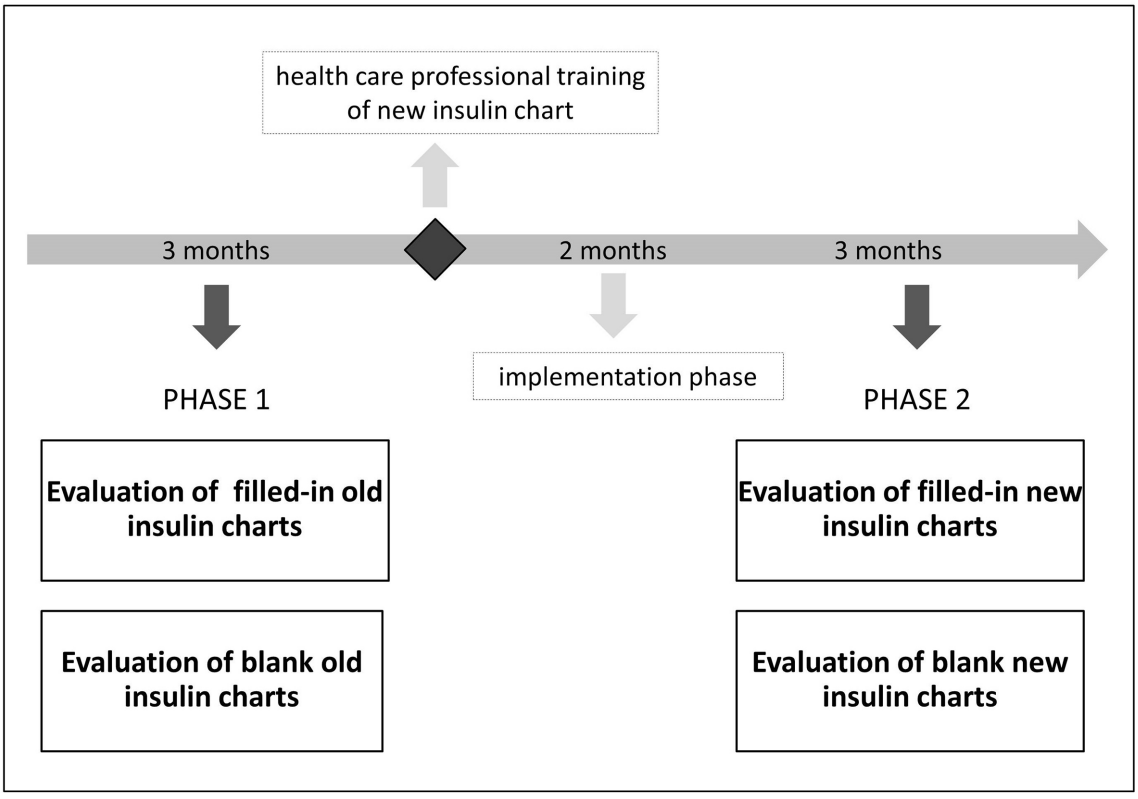

Figure 2 Timeline of study phases to identify structure, documentation and treatment quality.

of the nine wards for at least 1 hour were evaluated for a maximum of 7 days. A before–after comparison was conducted, in which the evaluation of the filled-in old insulin charts was compared with the evaluation of the filled-in new insulin charts. For both evaluations a paper-based data entry form was developed including relevant quality indicators.[10 11 17 24 25] The primary objective was to compare the number of documentation errors for insulin administration (primary endpoint). The following four items were generated for the definition of documentation errors for insulin administration:

- Name of insulin was not written complete/legible/comprehensible,
- Unclear dose,
- No initialling when insulin was administered,
- Time of administration was not clearly documented.

Any chart with at least one documentation error for insulin administration in the 7-hour audit period was counted as one documentation error for insulin administration. Secondary endpoints included documentation errors for insulin prescription, documentation errors for insulin management, clinical patient characteristics, good diabetes day (calculated according to NaDIA[24 25]), hypoglycaemia management, patient identification as well as specific parameters of the new insulin chart. Documentation errors for insulin prescription (as defined by NaDIA[24 25] but excluding the item 'insulin not signed as given' and adapting the item 'insulin given/prescribed at the wrong time' to 'insulin was prescribed at the wrong time') and documentation errors for insulin management (as defined by NaDIA[24 25]) were counted as one error when any chart had at least one documentation error for insulin prescription or documentation error for insulin management in the 7-hour audit period.

Data management

All patient-related data were pseudonymised with subject numbers following data protection guidelines. As data were collected by one scientist, a validation was conducted to ensure data plausibility. Therefore, 20 old insulin charts and 20 new insulin charts were randomly chosen and evaluated regarding the primary endpoint 'documentation errors for insulin administration' by two independent raters. A per cent agreement of 90% (95% exact CI: 76% to 97%) was observed. In order to check and ensure completeness, correctness and accuracy of data entry, an internal quality control was performed by two persons. All data relevant to the study are included in the article or uploaded as supplemental information.

Data sharing statement

No additional data available.

Patient and public involvement

Patients were not directly involved in the study.

Statistical analysis

For the primary endpoint comparison a sample size calculation was conducted. A χ^2 test was used to check for differences in the quality of old and new insulin charts. A total of 93 old insulin charts and 93 new insulin charts

were needed to obtain a power of 80%. An absolute reduction of 20% in documentation errors for insulin administration, and an error rate of 70% for the old insulin charts, which was based on previous study results,[23] were assumed. Depending on availability, in a first step up to 15 filled-in old insulin charts and in a second step up to 15 filled-in new insulin charts were collected per ward. Data on structure quality were analysed by using EvaSys, a digital survey tool[26] and data on documentation and treatment quality were analysed by using IBM SPSS Statistics 23.[27] Data were summarised with descriptive statistics. For numerical data—depending on distribution—mean, SD, median, minimum and maximum were calculated. Categorical data are presented as relative and absolute frequency. Number of old insulin charts and new insulin charts with documentation errors for insulin administration and number of hypoglycaemic episodes were compared using a χ^2 test or Fisher's exact test. A two-sided significance level of 5% indicates statistical significance.

RESULTS

Structure quality of blank old versus new insulin charts

In phase 1 a total of 84 healthcare professionals (51 physicians, 32 nurses and 1 not specified) completed the questionnaire regarding structure quality of blank old insulin charts and in phase 2 a total of 153 healthcare professionals (28 physicians, 123 nurses and 2 not specified) completed the same questionnaire for blank new insulin charts. The Likert type response scale indicated a shift towards agreeing answers (code 3 and 4) by healthcare professionals for improved structure quality of the new insulin chart for all nine items (figure 3). Comparing the blank old versus new insulin charts, healthcare professionals indicated that the documentation of prescription and administration of BG lowering medication was more clearly arranged (2.3±1.0 vs 3.0±0.9), the correction scheme was better integrated (1.7±1.0 vs 3.1±1.0), boxes for documentation of measured BG values were more clearly visualised (2.8±1.0 vs 3.4±0.8), there was more space for insulin prescriptions (2.3±1.0 vs 3.3±0.8) and for documentation of hypoglycaemia treatment (2.0±0.9 vs 2.8±0.9) on new insulin charts. Transparency of insulin prescription and insulin administration (2.6±0.9 vs 3.1±0.8), as well as support of confirmation of both processes with initials was increased (2.5±1.2 vs 3.3±0.8), and documentation of all relevant information regarding BG management was easier (2.1±0.9 vs 3.0±0.9) on new insulin charts. As a single item, difficulties with nursing and medical responsibilities in completing the insulin chart were found to be almost constant (2.6±1.0 vs 2.7±1.1).

Documentation and treatment quality of filled-in old versus new insulin charts

A total of 108 filled-in old insulin charts and 100 filled-in new paper-based insulin charts of inpatients receiving insulin were evaluated (phase 1 vs phase 2). Patient characteristics and treatment modalities of both groups are given in table 1.

The number of documentation errors for insulin administration (primary endpoint) was significantly higher for the old insulin charts compared with the new insulin charts (83 (77%) vs 5 (5%)) (p<0.001). Each parameter of documentation errors for insulin administration was distinctly higher on old insulin charts than on new insulin charts. Documentation errors for insulin prescription were more frequent on old insulin charts (108 (100%) versus 42 (42%)), whereas documentation errors for insulin management rarely occurred in any group (11 (10%) versus 8 (8%)). A detailed breakdown of listed parameters for documentation errors is shown in table 2.

Both groups had a mean of 4±2 good diabetes days scaled to hospital stay days. Most frequently BG values >11.0 mmol/L (198 mg/dL) were responsible for not achieving good diabetes day criteria, whereas BG values <4.0 mmol/L (72 mg/dL) and inappropriate BG measurement frequency occurred less. Overall, 26 vs 18 hypoglycaemic episodes (BG<4.0 mmol/L (72 mg/dL), p=0.28), including 7 vs 2 severe hypoglycaemic episodes (BG<3.0 mmol/L (54 mg/dL), p=0.17) were documented on old versus new insulin charts, respectively. Treatment of severe hypoglycaemia was documented in six out of seven cases on old charts versus in both cases on new charts, respectively. Documented treatment modalities included four times infusion of intravenous dextrose on old charts, whereas in all remaining cases oral carbohydrates were given.

Moreover, 12% absolute improvement in documentation of patient identification (78% vs 90%) was achieved by implementing the new insulin chart. Documentation of HbA1c (glycatedhaemoglobin) value on insulin charts was rare in both groups (1% vs 7%). Additionally, diabetes type was documented on 47%, pre-diabetes therapy on 17%, correction scheme on 28% and glomerular filtration rate on 6% of the filled-in new insulin charts.

DISCUSSION

The results of this study indicate that improved inpatient diabetes care was achieved by implementing a new insulin chart.

Erroneous documentation of insulin administration was significantly lower in new compared with old insulin charts. The design of the new chart was found suitable to improve all parameters of documentation errors for insulin administration. For example, errors regarding initialling of insulin administration by nurses were distinctly lower on new insulin charts compared with the previously used insulin charts. Our finding (3%) is similar to a rate of 4% not signed as given on audited drug charts at the NaDIA.[14] Thus, a comprehensible documentation of mandatory administration data for effective and safe glucose management was guaranteed by implementation of this new insulin chart. A Scottish study, which identified

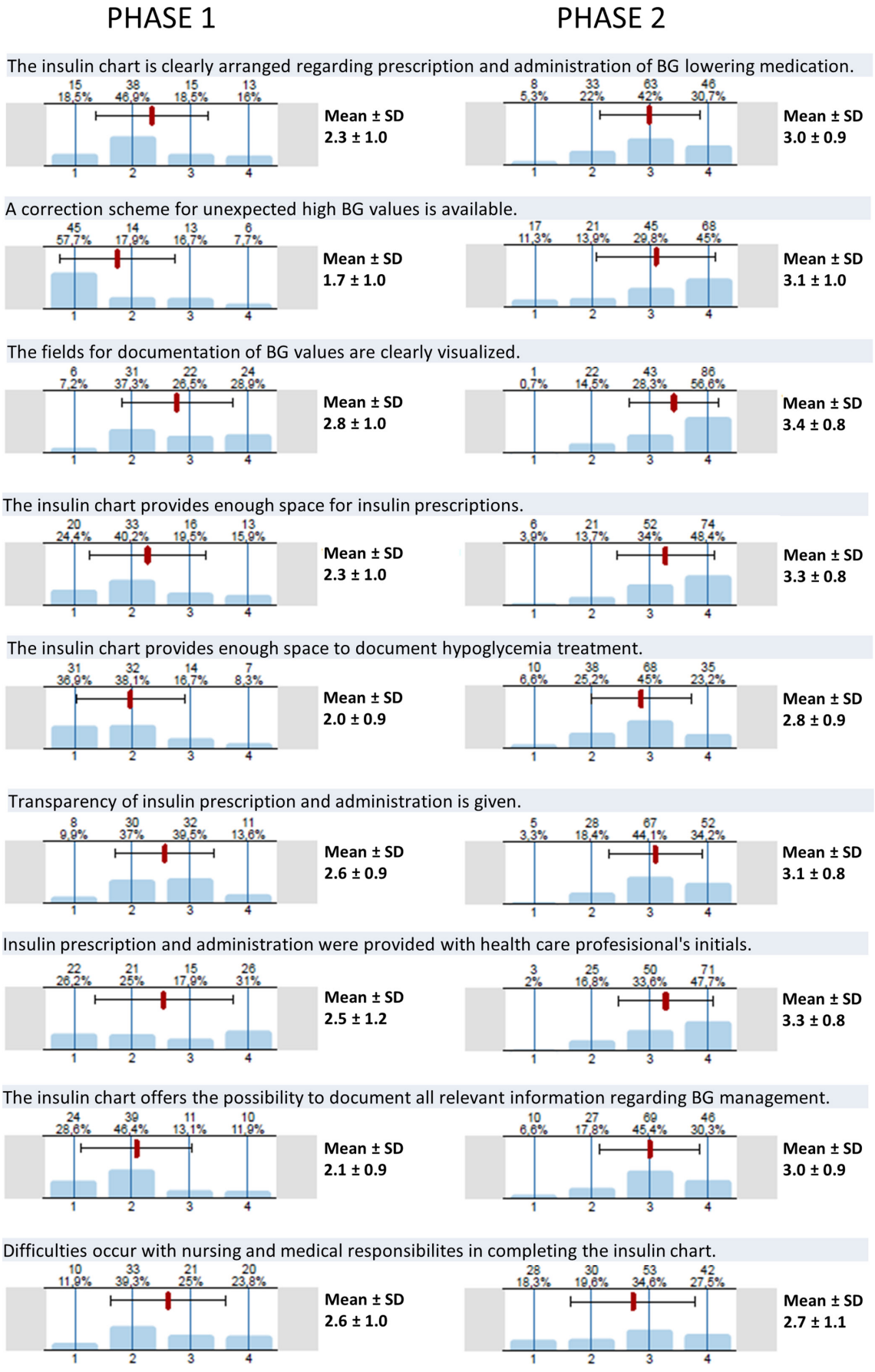

Figure 3 Structure quality of insulin charts assessed by physicians and nurses on a 4-point Likert type response scale ('I disagree', 'I partially disagree', 'I partially agree' and 'I agree' coded as 1 to 4). BG, blood glucose.

Table 1 Patient characteristics and treatment modalities of 208 inpatients treated with insulin

	Patients with old insulin charts (n=108)	Patients with new insulin charts (n=100)
Age, years (mean±SD)	71±11	71±12
Female (n (%))	51 (47)	42 (42)
Admission type: emergency (n (%))	63 (58)	66 (66)
Reasons for admission (n (%))		
Medical non-diabetes specific reasons (eg, respiratory, cardiovascular)	89 (82)	81 (81)
Diabetes specific reasons for admission	19 (18)	19 (19)
Nights in the hospital (median (min-max))	8 (1–86)	7 (1–66)
Foot disease (previous ulcer, amputation, Charcot) (n (%))	17 (16)	18 (18)
Renal replacement therapy (n (%))	10 (9)	7 (7)
Diabetes type (n (%))		
Diabetes type 1	6 (6)	2 (2)
Diabetes type 2	81 (75)	87 (87)
Other diabetes type	6 (6)	9 (9)
Not documented	15 (14)	2 (2)
HbA1c (mmol/mol) (mean±SD)	62±14	67±21
BG per patient		
mmol/L (mean±SD)	10.3±2.8	10.3±2.4
mg/dL (mean±SD)	186±50	186±44
BG measurement frequency per day (mean±SD)	3±1	3±1
Treatment modalities (n (%))		
Premixed insulin	43 (40)	42 (42)
Basal insulin	28 (26)	26 (26)
Basal-bolus insulin	12 (11)	13 (13)
Prandial insulin	4 (4)	2 (2)
Correctional bolus insulin	57 (53)	51 (51)
DPP-4 inhibitor	31 (29)	25 (25)
Metformin	14 (13)	15 (15)
Sulfonylurea	4 (4)	6 (6)

BG, blood glucose; DPP-4, dipeptidyl peptidase-4; HbA1c, glycated haemoglobin.

evidence-based subcutaneous insulin care clusters to develop a new insulin chart showed similar improvements in the correct documentation of insulin administration after implementing a new insulin chart.[10]

Regarding documentation errors for insulin prescription, we identified half as many errors on the new insulin charts. The detailed analysis of documentation errors for insulin prescription indicated that all but one parameter, the initialisation of the prescription, were sufficiently improved on new insulin charts and comparable to recent data of the NaDIA.[14] None of the previously used insulin charts at our institution had provided a dedicated area for the initialling of therapy which is reflected in 100% documentation error rate in the baseline evaluation. Although the new design supports this legal prerequisite of documentation, a sufficient practice change among physicians has not yet been achieved. Similarly, the Scottish study did not report a significant change in insulin prescription by implementing a new insulin chart. The authors argued, that this may arise from longstanding practice on the wards which is not easily changed.[10] The same challenge may also apply to our hospital and hence further training should be offered to healthcare professionals to improve initialling of prescription. Additionally, pharmacists should be involved in the insulin prescription process when possible to review charts and to indicate any concerns to physicians and nurses to improve insulin error reduction strategies.[28–30]

Documentation errors for insulin management were rare in both groups and remained lower than the average error rate reported in a recent NaDIA report.[14] The number of good diabetes days, an indicator for established glycaemic control without the occurrence of hypoglycaemia, remained at a higher level compared with the benchmark of insulin treated patients in the NaDIA audit.[14] Of note, the number of hypoglycaemic

Table 2 Documentation errors for insulin administration, prescription and management with detailed listed parameters for 7 days of inpatient stay

Documentation error type	Old insulin charts (n=108)	New insulin charts (n=100)
Documentation error for insulin administration (n (%), p<0.001)	**83 (77)**	**5 (5)**
Name of insulin was not written complete/legible/comprehensible	17 (16)	3 (3)
Unclear dose	25 (23)	1 (1)
No initialling when insulin was administered	55 (51)	3 (3)
Time of administration was not clearly documented	46 (43)	0
Documentation error for insulin prescription (n (%), p<0.001)	**108 (100)**	**42 (42)**
Insulin was not written up	27 (25,0)	0
Name of insulin was not written complete/legible/comprehensible	19 (18)	0
Unclear dose	32 (30)	1 (1)
Unit was written unclear	30 (28)	0
No initialling when insulin was prescribed	108 (100)	42 (42)
Insulin was prescribed at the wrong time	0	0
Documentation error for insulin management (n (%), p=0.637)	**11 (10)**	**8 (8)**
Insulin not increased when BG persistent >11.0 mmol/L (198 mg/dL) and a better control was appropriate for patient	10 (9)	7 (7)
Insulin was not reduced when unexplained BG<4.0 mmol/L (72 mg/dL)	1 (1)	1 (1)
Inappropriate omission of insulin after hypoglycaemic episode	0	0

BG, blood glucose.

events, including severe episodes, was, although non-significantly, lower in new insulin charts and treatment of severe hypoglycaemia was documented in all cases on new insulin charts. Thus, regarding overall treatment quality, the use of the new insulin chart seems to be clinically safe and beneficial to hospitalised patients that need insulin therapy to control glycaemia.

Our evaluation of structural quality features showed a shift towards agreeing answers by nurses and physicians for improved structure quality of the new insulin chart for all nine items. Most of the structural improvements led to the desired positive changes in documentation quality. However, not all offered documentation possibilities were used to the same extent in clinical routine. As discussed above, there was a distinct difference in the authorisation of prescription or confirmation of administration through initialising on the new insulin chart by physicians and nurses, respectively.

In this regard it is important to emphasise the potential limitation that the evaluation of filled-in insulin charts may not reflect the entire actual care at the wards. Similar to the Scottish study it can be assumed that there is a potential gap between the actual quality of care and the documentation.[10] The implementation report of a national subcutaneous insulin chart in the Australian project observed a decrease in the proportion of doses initialled as having been administered and orders where the prescriber had signed. The authors argued, that this does not necessarily mean that the insulin doses were not given, as otherwise this would be seen in increasing BG values.[17] Of note, an appropriately documented insulin dosing on an insulin chart solely does not guarantee that all system and human factors have been adequately respected when the insulin dosing has been performed.[28 31] The preparation and administration process is complex, errors are multifaceted and may be related to, for example, missed resuspension of NPH insulin, inappropriate mixtures of different insulins when using a syringe, overdosing due to use of wrong insulin concentration, use of an improper injection site, injection of a prandial insulin despite omission of nutritional intake or delayed injection due to excessive workload of the nursing staff. Education and resource availability have been claimed as important interventions by healthcare professionals to administer insulin in a timely and safe way for every patient.[29] To reduce the workload of the nursing staff a policy regarding self-administration and self-management and it's standardised documentation on the new chart has been developed.

Furthermore, the observed beneficial effects in the current investigation may not be solely attributed to the use of the new insulin chart as the implementation was accompanied by extensive training measures to improve compliance of medical and nursing staff. The limitation of a missing control group, which has undergone comparable training measures with the previous insulin charts in order to assess the impact of the new form on its own is acknowledged. Usefulness of a control group can be limited when evaluating a complex intervention in an open system such as a ward area in a hospital, where it is challenging to control for multiple confounders.

To ensure that our new insulin chart is empirically and theoretically well founded for our institutional setting we integrated results of previous audit data, followed international and local standards when developing the new insulin chart and performed preclinical piloting of the prototype.[23] However, we acknowledge that using the concise

methodology of the Medical Research Council framework[32] could have further improved several phases of our complex intervention, for example, the phase of assessing feasibility and piloting by performing clinical testing of the new chart or the phase of evaluation by using focus groups and in-depth interviews to explore the implementation of the intervention, contextual factors and potential mechanisms of action. Additionally, the implementation of one standardised insulin chart per se in our institution may have contributed to a reduction of documentation errors, as junior doctors rotating between wards have to deal with one insulin chart instead of four. It can be expected that similar to observational charts, variations in prescription chart design are related to different prescription error frequency and through chart standardisation prescription error rates can be reduced in insulin charts as well.[33]

Moreover, the implementation and subsequent effects of the new insulin chart to other, for example, surgical disciplines may be different. However, insulin prescription and administration should not differ between conservative and surgical disciplines and accompanying training measures should allow a safe and effective implementation.

When implementing any type of insulin chart, the integration within the standard prescription chart process needs to be secured. In particular, the process of documentation and administration of intravenous insulin necessitate cautiousness.[34] The use of electronic prescription systems with integrated insulin charts may help to reduce interface errors between different prescription systems. International guidelines recommend electronic diabetes documentation as necessary for optimising diabetes inpatient care.[4 15] This is also confirmed by NaDIA, where hospitals that were prescribing diabetes medication electronically were less likely to have prescription errors.[14] Electronic systems with clinical decision support have the potential to reduce errors and to increase treatment quality.[35]

A strength of the study is that improvements in documentation quality were connected with beneficial clinical outcome. Moreover, the project was performed in daily clinical routine work as an essential quality assurance project. The hours spent for implementation were covered out of general employment and, thus, feasibility of a rollout in comparable hospital institutions can be assumed.

Nevertheless, a lesson learnt from the present work was that training of the nursing and medical staff is a real challenge in a typical hospital shift rotation system.

Another critical aspect when designing a new insulin chart is an early review of the necessity of all fields on the new insulin chart. It can be assumed that, similar to the Scottish study, the more fields that need to be filled-in the less likely any of them will be charted.[10] In our case the item glomerular filtration rate will be removed from the chart as the degree of filling-in was low and importance for the actual treatment process in daily routine care has been scrutinised.

Finally, we agree with the conclusion of the Australian Quality Initiative that further optimisation of specific endpoints, such as initialling of physician's prescription or documentation of hypoglycaemia treatment should be addressed through effective change management processes and more explicit training and education for healthcare professionals, rather than further modification of chart design.[17] The insulin chart, as a standardised documentation of diabetes management, is only one component for good diabetes inpatient care. It is also important to address the knowledge gaps regarding insulin therapy and insulin use among healthcare professionals.[4 5 9 28 29]

CONCLUSION

Inpatient diabetes care was optimised through implementation of the new insulin chart. Structural changes on the new insulin chart along with accompanying training measures throughout the implementation process, not only led to better quality of insulin chart structure, but also improved documentation quality of filled-in new insulin charts and supported safe management of glycaemic control. The present work supports a rollout of the new insulin chart at further departments, and sustainability of the beneficial effects in the long-term has to be demonstrated in further investigations.

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Contributors JK, GS, KL, BS, TRP and JP designed and performed the study, interpreted data and contributed to discussions. RR performed statistical analysis. JP, GB, CT and TRP supervised the project and JP is the guarantor of this work.

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Competing interests None declared.

Patient consent for publication Not required.

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Provenance and peer review Not commissioned; externally peer reviewed.

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