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Practical Diabetes

Development and Implementation of a Diabetic Ketoacidosis Protocol for Adults With Type 1 and Type 2 Diabetes at a Tertiary Care Multicampus Hospital

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Key Messages

- Implementation of a preprinted protocol for the management of diabetic ketoacidosis, supported by ongoing user feedback and continuous revisions, resulted in standardized best practices and improved outcomes for care of people with diabetic ketoacidosis.
- A strong implementation plan and ongoing support for end-users were critical for the successful uptake of the diabetic ketoacidosis protocol.

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ABSTRACT

Objectives: Diabetic ketoacidosis (DKA) is associated with significant morbidity and mortality. Using standardized protocols for DKA management improves outcomes and is recommended in Diabetes Canada's clinical practice guidelines. Audits of DKA care at our institution revealed inconsistent management. We developed, piloted and evaluated a standardized DKA protocol adapted into preprinted order sets for use in the emergency department and the acute monitoring area.

Methods: The protocol was developed by an expert committee on the basis of Diabetes Canada's clinical practice guidelines, a literature review and an environmental survey. A before-and-after analysis was used. Uptake of the DKA protocol and clinical outcomes were monitored through statistical process control.

Results: Patients admitted postprotocol (n=55, mean age 37.9 years [SD 17.5 years], 62% male, 85% type 1 diabetes) were compared to those admitted preprotocol (n=55, mean age 43.3 years [SD 17.5 years], 53% male, 67.2% type 1 diabetes). Postimplementation, 87% of patients were managed according to the protocol. Postprotocol ordering of appropriate laboratory investigations increased, appropriate intravenous (IV) fluid resuscitation improved, continuation of IV insulin until anion gap closure increased, mean time to anion gap closure decreased and mean length of stay was reduced. Of those surveyed, 85% of nurses and 74% of physicians felt that the protocol improved patient care, and 75% of patients rated their DKA management as being satisfactory.

Conclusions: Successful implementation of a standardized preprinted protocol for DKA management significantly improved best practices for DKA management and was valued by treating clinicians.

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RÉSUMÉ

Objectifs : L'acidocétose diabétique (ACD) est associée à une morbidité et à une mortalité importantes. L'utilisation de protocoles normalisés de prise en charge de l'ACD améliore les résultats cliniques et est recommandée par les lignes directrices de la pratique clinique de Diabète Canada. Les audits de soins de l'ACD de notre établissement ont révélé des incohérences dans la prise en charge. Nous avons élaboré, piloté et évalué un protocole normalisé de prise en charge de l'ACD adaptable aux modèles d'ordonnances préimprimées qui peut être utilisé au service des urgences et à l'unité de surveillance des patients en phase aiguë.

Méthodes : Un comité d'experts a élaboré le protocole en se basant sur les lignes directrices de la pratique clinique de Diabète Canada, une revue de littérature et une étude de l'environnement. Une analyse avant-après a été utilisée. L'utilisation du protocole de l'ACD et les résultats cliniques ont été surveillés par contrôle statistique du processus.

Résultats : Nous avons comparé les patients admis après le protocole (n=55, âge moyen de 37,9 ans [ÉT de 17,5 ans], 62 % d'hommes, 85 % de diabète de type 1) aux patients admis avant le protocole (n=55, âge moyen de 43,3 ans [ÉT de 17,5 ans], 53 % d'hommes, 67,2 % de diabète de type 1). Après la mise en œuvre, 87 % des patients ont été pris en charge en fonction du protocole. Le nombre d'ordonnances d'analyses de laboratoire appropriées après le protocole a augmenté, la réanimation liquidienne par voie IV appropriée s'est améliorée, le maintien de l'insuline par IV jusqu'à la fermeture du trou anionique a augmenté, le temps moyen avant la fermeture du trou anionique a diminué et la durée moyenne du séjour a été raccourcie. Parmi les répondants, 85 % des infirmières et 74 % des médecins ont reconnu que le protocole améliorait les soins aux patients, et 75 % des patients ont jugé que leur prise en charge de l'ACD était satisfaisante.

Conclusions : La réussite de la mise en œuvre d'un protocole normalisé préimprimé de prise en charge de l'ACD a favorisé de manière significative de meilleures pratiques de prise en charge de l'ACD et était appréciée par les cliniciens traitants.

Introduction

Diabetic ketoacidosis (DKA) is a life-threatening metabolic complication of diabetes mellitus that is associated with significant morbidity and mortality (1). In Canada, it results in 5,000 to 10,000 hospitalizations annually and carries a mortality rate of 4% to 10% (1).

Over the past decade, several studies have demonstrated the benefits of using protocols and clinical pathways to standardize and improve outcomes in DKA management (2–4). As such, their use has been recommended as the preferred method of care delivery for people with DKA (2,5). However, the presence of guidelines alone may not be adequate to ensure optimal care (6). An audit of the Joint British Diabetes Society consensus guideline for DKA management indicated that although adherence to guidelines was high for initial DKA management, later management and monitoring were insufficient, resulting in high rates of hypokalemia and hypoglycemia (7).

A review of DKA management at our institution revealed inconsistencies in DKA treatment. Of 24 DKA cases reviewed in 2013, only 54% received appropriate fluid resuscitation, 79% had IV insulin continued to the closure of the anion gap, and 67% received all of the recommended laboratory investigations. A quality-improvement initiative was undertaken. The objective was to develop, implement and evaluate an evidenced-based protocol adapted into preprinted order sets for the management of DKA. We aimed to achieve 80% compliance with the DKA protocol in our institution by June 2016 and hypothesized that outcomes would improve with protocol use.

Methods

Study setting and participants

The Ottawa Hospital is a multicentre, bilingual academic teaching hospital in Ottawa, Ontario. There are 1,122 beds and 172,445 emergency room visits per year. Patients with DKA are admitted through the emergency room and managed in the acute monitoring area of the internal medicine ward or the intensive care unit (ICU), depending on severity of presentation at the 2 inpatient campuses, the Civic Campus and the General Campus. Paper orders are written by physicians and are then incorporated into the paper and electronic medical records.

Consecutively admitted patients with DKA were identified over 2 time periods: September 2013 to March 2014 (preintervention) and September 2015 to June 2016 (postintervention). The diagnosis of DKA required the presence of metabolic acidosis (pH <7.3), an elevated anion gap greater than 12 and positive serum ketones. Only patients with DKA management initiated at our centre were included.

Intervention development and implementation

The development and implementation phase of the protocol was based on the Ottawa Model of Research Utilization, a framework for adopting innovations that involves 6 steps: setting the stage, assessing barriers and facilitators, selecting and monitoring knowledge translation strategies, monitoring the adoption and evaluating the outcomes (8) and using the Institute for Health Care Improvement Model for Improvement. A multidisciplinary expert committee consisting of key stakeholders in internal medicine, emergency medicine, endocrinology, nursing and pharmacy developed a protocol based on a literature review, the 2013 Diabetes Canada clinical practice guidelines for DKA management, consensus expert opinion and stakeholder feedback. The protocol was adapted into 2 standardized preprinted order sets (Supplementary Figure 1) for use in the emergency room, the ICU or acute monitoring area. End-user feedback resulted in modifications to the protocol to clarify potassium replacement orders, adjust the insulin-infusion protocol and automatically notify the doctor for reassessment if pH and the anion gap remained abnormal (Supplementary Figure 2).

An implementation strategy was used; it included stakeholder engagement, discipline-specific education sessions and an analysis of barriers to and facilitators of uptake specific to local areas. The education intervention was designed by a multidisciplinary committee composed of an endocrinologist, general internist, advanced practice nurse and resident physician. Discipline-specific, case-based workshops targeted to physicians, resident physicians,

Table 1
Clinical outcomes of the preimplementation and postimplementation groups

Parameter	Preimplementation	Postimplementation	p value
Proportion with appropriate fluid management	33.3%	93%	<0.01
Proportion with appropriate laboratory investigations	60.0%	91.0%	<0.01
Proportion with intravenous insulin continued until anion gap closure	76.0%	100%	<0.01
Mean time (hours) to anion gap closure	10.5	6.0	<0.01
Proportion with hypokalemia	18.1%	5.4%	0.04
Proportion with hypoglycemia	3.6%	0%	0.15

nurses and clerical staff delivered by opinion leaders were conducted 2 months prior to implementation. Feedback was obtained from protocol users through questionnaires and through direct communications e-mailed to project leaders.

E-mail reminders to use the protocol occurred when clerical or nursing staff noted that the protocol was not used. Nonadopters were approached to discuss their barriers to implementation, and coaching was provided as needed.

Data collection

A trained data extractor (MM) abstracted data concerning patient demographics, medical histories, diabetes type and duration, biochemical parameters, medication use, capillary blood glucose measurements, insulin and fluid ordered, fluid received and precipitants of DKA. Protocol use was collected and reviewed monthly.

Outcome measures

Table 1 outlines the clinical outcomes evaluated. Process measures and balance measures were also evaluated. A target of 80% of all DKA orders written on the new DKA order forms was established. This goal recognized that a small proportion of patients would require unique treatment regimens that were not easily supported by the form.

Analysis

Descriptive statistics were used to depict the baseline characteristics of patients. Nominal data were analyzed using chi-square tests, and continuous data were analyzed using independent *t* tests. An alpha <0.05 was considered statistically significant.

A before-and-after analysis was used to evaluate the effect of a hospitalwide implementation of a paper-based, preprinted DKA protocol on clinical outcomes and processes of care. Uptake of the DKA protocol and clinical outcomes was monitored postimplementation by the use of statistical process control through the development and use of Shewhart charts to track the progress and stability of process change.

Microsoft Excel and QI macros were used to analyze the data.

Patient and caregiver satisfaction

The first 25 patients in the postprotocol group were contacted by telephone following their discharge and were asked to complete a satisfaction survey about the management of their DKA. Nurses and physicians provided feedback through an electronic survey during protocol implementation.

Ethics review

The protocol was reviewed by the Ottawa Hospital Research Ethics Board.

Results

A total of 110 DKA admissions (55 preintervention and 55 postintervention) were evaluated. Male patients accounted for 52% of the preintervention and 62% of the postintervention populations. Most patients had histories of type 1 diabetes (67% preintervention and 85% postintervention). The most common precipitants of DKA were infections and insulin omission. Mean admission glucose levels were significantly higher (35 ± 15.8 mmol/L vs. 28.8 ± 13.9 mmol/L; $p=0.03$) and mean admission pH levels were significantly lower (7.12 ± 0.17 vs. 7.19 ± 0.14; $p=0.01$) in the preintervention group. There was no difference between the preintervention and postintervention groups as to the setting (ICU vs. ward) where the protocol was used. One patient in each group was managed in the ICU, while the remainder were managed on the ward.

Process outcomes

Postimplementation, 87% of patients admitted with DKA were managed according to the protocol (Figure 1). Prior to implementation, 100% of endocrinology residents, attending endocrinologists, internal medicine trainees and attending internists, and 85% of nursing staff were trained in the DKA protocol. In total, 125 attending physicians (80 emergency physicians, 25 general internists and 20 endocrinologists) and 141 resident physicians (85 internal medicine, 6 endocrinology and 50 emergency medicine trainees) were trained in the protocol. Approximately 300 nurses (230 emergency room nurses and 70 acute monitoring area nurses) received training. Training for physicians involved teaching sessions at departmental meetings, quality meetings, academic half-days and rounds. An e-mail communication of the protocol with instructions was sent to all involved physicians and residents.

Nurses were educated through presentations at orientation, lunch and learns, in-services, education updates and e-mailing of the protocol with instructions. An e-mail reminder to users occurred 5 months after implementation when protocol use dropped (Figure 1). When use of the protocol dropped again at 7 and 8 months postimplementation, project leaders contacted resident physicians who were noted to be failing to use the protocol. Feedback was obtained about barriers to using the form, and targeted support and education were provided.

Clinical outcomes

Clinical variables improved significantly (Table 1) (Supplementary Figure 3). There were 2 patients in the preprotocol group who developed hypoglycemia (serum glucose <4 mmol/L) and none in the postprotocol group. Hypokalemia ($K^+ <3.3$ mmol/L) was significantly higher in the preprotocol group. No patients in either group had serious complications such as shock or thrombosis.

Balance outcomes

Consultation requests to the endocrinology service and diabetes nurse specialists increased by approximately 30% with implementation of the protocol. The average length of stay decreased from 4.4 to 3.0 days. During the same time period, the average length of stay for acute admissions to general medicine services without diagnoses of diabetes decreased by 0.7 days, and length of stay for patients with diabetes admitted to general medical services

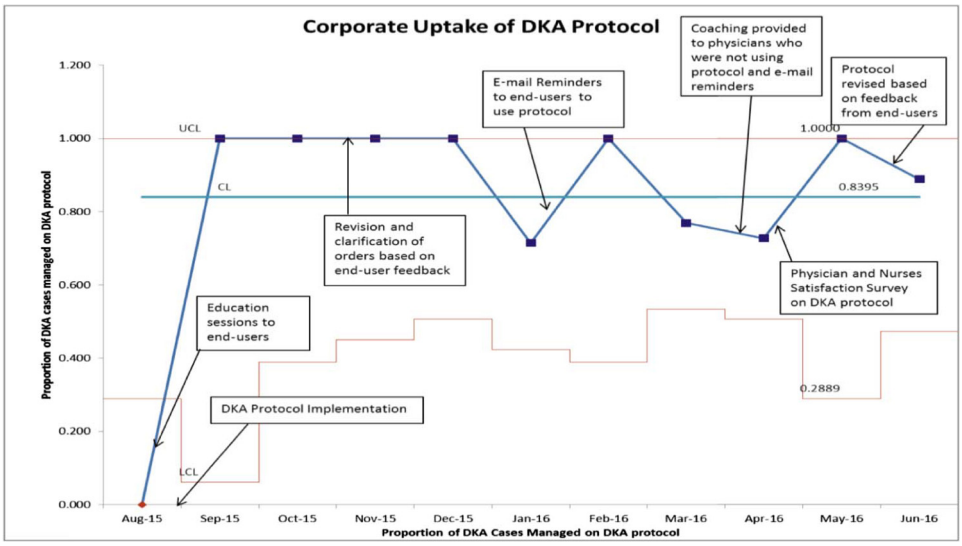

Figure 1. Protocol uptake. *DKA*, diabetic ketoacidosis.

decreased by 0.4 days. Of the patients, 75% rated the management of their DKA under the protocol as being satisfactory. The main patient concerns included the frequency of blood work and pain with intravenous insertions. Of the nurses and physicians who were surveyed, 85% and 74%, respectively, felt that the protocol improved patient care.

Discussion

We successfully designed and implemented a standardized, evidence-based protocol for DKA management at a multicampus tertiary care centre that led to safer practices and standardized care regardless of the treating physician's knowledge of or experience with DKA management. Clinical outcomes improved without an increase in either hypoglycemia or hypokalemia. The order set was highly supported by treating clinicians, and its use was associated with good patient satisfaction.

Because of the recognized need to improve DKA management, national guidelines have advocated the use of treatment protocols (2). Numerous studies have shown that treatment protocols improve outcomes in hyperglycemic emergencies (9,10). Similar to our findings, those of Bull et al (2007) showed that protocol implementation was associated with a decreased length of stay and a shorter time to anion gap closure without increased hypoglycemia or hypokalemia (10). Hara et al (2013) examined the effects of a mandatory protocol for DKA management in an academic medical centre and found that protocol use led to a shorter time to resolution of acidosis, a decrease in length of stay and no difference in hypoglycemia rates (11). Laliberte et al (2017) also found improvement in compliance with DKA guidelines when a DKA order set was used; however, they experienced a higher rate of hypoglycemia in the protocol group (12). In contrast to our protocol, which contained a detailed, dynamic insulin dosing scale that did not require physician verification for dosage changes, their protocol had limited suggestions for insulin infusion changes that required physician verification, which may have resulted in delays in changing insulin dosages.

In order for the benefits of a protocol to be realized, it must be used. Evans et al (2014) found improvement in best practices DKA management through the implementation of a DKA protocol but only for those treated with full fidelity to the DKA protocol (13). A strength of our study is the high rate of usage of our protocol in our institution, a rate that contrasts with that of most published DKA protocols.

Optimal implementation requires a robust knowledge-translation strategy, ongoing stakeholder involvement, use of champions and tailoring of the intervention to local barriers and facilitators (8,14–16). Our protocol was developed by using a multidisciplinary approach that relied on key evidence and a strong implementation plan. The use of the Ottawa Model of Research Utilization was helpful in providing a framework for assessing the barriers to and supports for implementation, and it promoted early engagement of the opinion leaders, key stakeholders and adopters (8). The model also promoted real-time monitoring of the intervention with frequent audits and feedback on protocol use. This was one of the most important factors in promoting the confidence and engagement of end-users of the protocol.

Features of the protocol itself may also have contributed to uptake because it facilitated the management of DKA for treating physicians. Suggestions for alternative fluid replacement regimens for patients with heart failure and end-stage renal disease, potassium-replacement recommendations and dosing adjustments to insulin rates based on dynamic insulin dosing scales provided the treating clinicians with easily accessible evidence-based treatment recommendations.

Consultations with the Endocrinology Service and the Diabetes Nurse Specialist service increased with the use of our protocol, an effect that has also been found in other studies (17). The increased rate of consultations with nurse specialists may be beneficial for improved long-term patient outcomes because the specialists' involvement in DKA management has been shown to lower readmission rates through increased education and more frequent follow ups (18,19).

A major barrier to adoption of the protocol was the concern that use of a standardized order set could have a negative effect on the education of medical trainees. It was perceived that less active decision making is required when using a standardized form. In a prospective cohort study that assessed education outcomes in medical students who used manual order writing compared to a standardized order set, there was no difference in total scores between students who used the order set vs. those who did not (20). Although education outcomes were not formally assessed in our study, the anecdotal feedback from attending physicians

concerning their perception of the educational impact of the form was positive.

Limitations of the study include the retrospective nature of the chart review and the relatively small sample size. Some data may have been missing during the chart review due to inconsistent documentation. Patients in the preprotocol group seemed to have more severe DKA. However, the differences were clinically small. Finally, the intervention may have been prone to the Hawthorne effect; however, most corporate interventions to improve glycemic control were already in place during the baseline chart review and did not change during the protocol's implementation.

Conclusions

We demonstrated that implementation of a preprinted protocol for DKA management supported by ongoing user feedback and continuous revisions resulted in standardized best practices, facilitated improved outcomes for patients with DKA and was strongly supported by treating practitioners. A strong implementation plan and ongoing support for end-users was critical for the successful uptake. This approach may be useful for other hospitals with similar structures for DKA management.

Supplementary Material

To access the supplementary material accompanying this article, visit the online version of the *Canadian Journal of Diabetes* at www.canadianjournalofdiabetes.com.

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Author Disclosures

Conflicts of interest: none.

Author Contributions

Dr. Janine Malcolm lead the conception and design of the study, analyzed the data, wrote and revised the article, and performed the literature search. Dr. Medina Mohamed collected the data, helped with data interpretation, wrote and edited the manuscript. Dr. Angela Assal was involved in the conception and design and reviewed and edited the manuscript. Dr. Alan Karovitch was involved in the conception and design and reviewed and edited the manuscript. Dr. Loree Boyle was involved in the conception and design, the interpretation of the data, and reviewed and edited the manuscript. Dr. Edmond Kwok was involved in the conception and design of the study, the data interpretation, and edited and reviewed the manuscript.

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Supplementary Material

The Ottawa Hospital | L'Hôpital d'Ottawa

PHYSICIAN'S ORDERS
Emergency Department

Medication Allergies/Reactions	Substances or Food Allergies/Reactions
❑ None known	❑ None known

Diabetic Ketoacidosis (DKA) Protocol — Emergency

Instructions to Physician

Inclusion Criteria (need at least 2 features):
– Glucose greater than or equal to 14 mmol/L (note: glucose may be normal in DKA)
– pH less than or equal to 7.3
– Serum bicarbonate less than 22 mmol/L
– Anion gap greater than 12 mmol/L
– Positive serum beta-hydroxybutyrate or urinary ketones

Cautions:
Modifications may be required to the doses and/or rates on this form if the patient has:
– Renal failure
– Heart failure
– Age greater than 75 years

Init.	Non-Medication	Init.	IV and Medication (Medication, dose, route, frequency)
	Patient Weight: _____ kg		☑ Establish 2 to 3 peripheral IV lines
	Diabetes Type: ❑ 1 ❑ 2 ❑ Unknown		**Fluid Resuscitation (no KCl added) (caution in heart failure and renal failure):** After initial NS bolus (1–2 L), the recommended rate of NS is 500 mL/h × 4 hours followed by NS 250 mL/h × 4 hours.
	Monitoring: ☑ Resus/Emergent bed		❑ NS IV bolus _____ L over _____ minutes then,
			❑ NS IV 500 mL/h × 4 hours then,
	Vital Signs: ☑ Vitals q2h **OR** other: _____		❑ NS IV 250 mL/h × 4 hours
	☑ Accurate ins/outs q8h		❑ Maintenance fluids: _____
			❑ Other: _____
	Diet: ☑ NPO		☑ When blood glucose less than 14 mmol/L, start D5W at 100 mL/h (give in addition to fluid replacement if fluid resuscitation not complete)
	Initial Lab Investigations:		**Potassium (use separate IV line or y-site into above fluids):** Initiate potassium replacement when K less than 5.5 mmol/L. Start after first litre of NS.
	Blood: ☑ CBC, Na, K, Cl, CO_2, Mg, Ca, PO_4, Albumin, anion gap, creatinine, urea, HbA1c, CK, TNI		**Recommendations (caution in renal failure):** K 5.5 mmol/L or greater: No replacement K 4.1 to 5.4 mmol/L: NS with 20 mmol/L KCl IV K 3.3 to 4.0 mmol/L: NS with 40 mmol/L KCl IV K less than 3.3 mmol/L: KCl 10 mmol IV over 30 minutes × 2 and do not start IV insulin infusion, repeat serum potassium post-infusion of KCl
	☑ Venous blood gas, serum osmolality, serum beta-hydroxybutyrate		
	❑ Blood C+S × 2		
	Urine: ☑ R+M, C+S		**Initial Potassium Orders (choose one of the following options):**
	❑ beta-hCG (if female)		❑ KCl 10 mmol IV × _____ (each 10 mmol of KCl to be infused over a minimum of 30 minutes)
			❑ NS with 20 mmol/L KCl at _____ mL/h
	Diagnostics: ☑ ECG		❑ NS with 40 mmol/L KCl at _____ mL/h
	☑ Chest x-ray		❑ Other: _____
			☑ Call Physician if potassium less than 3.5 mmol/L or greater than 5 mmol/L with subsequent bloodwork
	Ongoing Investigations: ☑ Blood glucose by POCT q1h		☑ Subsequent potassium replacement should be individualized according to patient response and written as a new physician's order
	☑ Na, K, Cl, CO_2, anion gap; Venous blood gas: ❑ q1h ❑ q2h		**Analgesia:** ❑ Acetaminophen 325–650 mg PO q4h prn
	❑ Other: _____		**Antiemetics:** ❑ Ondansetron 4–8 mg PO/IV q6h prn
			❑ Dimenhydrinate 25–50 mg PO/IV q4h prn

Date (yy/mm/dd)	Time	Physician (printed)	Signature (Physician)
Date (noted)	Time	Processed by	Signature (Nurse)

SPO 355 A (REV 04/2017) ER 1–Chart 2–Pharmacy 3–Nursing

The Ottawa Hospital | L'Hôpital d'Ottawa

PHYSICIAN'S ORDERS
Emergency Department

Medication Allergies/Reactions	Substances or Food Allergies/Reactions
❑ None known	❑ None known

Diabetic Ketoacidosis (DKA) Insulin Infusion Protocol

Patient weight: _____ **kg**

- Start insulin regular IV infusion at _____ units/h (MD to calculate starting dose, **usual starting dose is 0.1 units/kg/h**) once potassium is greater than or equal to 3.3 mmol/L
- In ER, AMA or General Medicine Ward mix 50 units regular insulin in 250 mL NS (0.2 units/mL)
- Discontinue SC insulin
- If patient is wearing an insulin pump, discontinue pump

Insulin Infusion Adjustment:

1. Target range for blood glucose is 12–14 mmol/L.
2. Insulin infusion rate not to exceed 10 units/hour without notifying MD.
3. Measure blood glucose by POCT q1h until 2 glucose levels in target range, then q2h.
4. Resume q1h monitoring any time the insulin infusion rate is changed.
5. Document POCT blood glucose results on NUR 133.

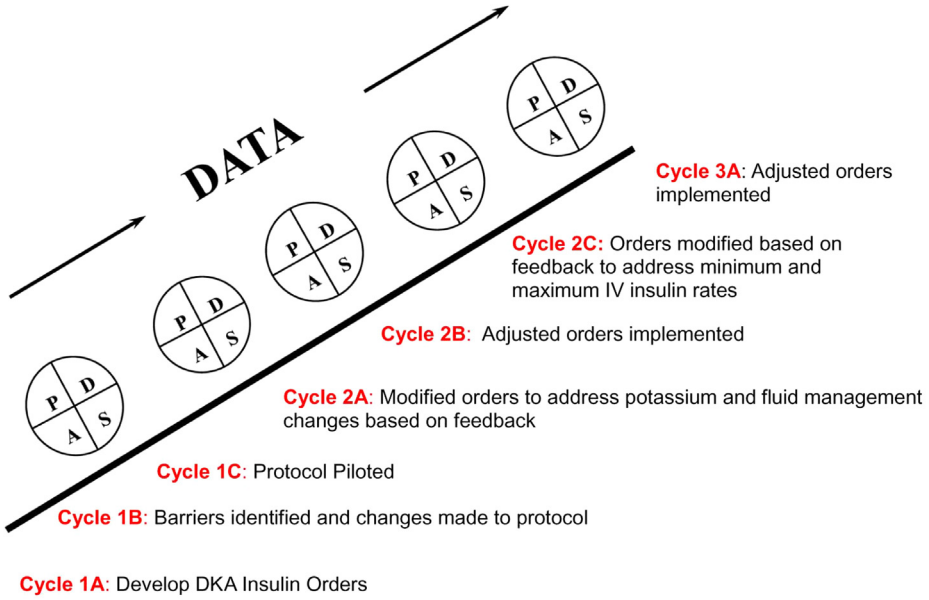
Blood Glucose (mmol/L)	Insulin Infusion Adjustment
Less than 4 mmol/L	• If glucose less than 4 mmol/L give 50 mL of D50W IV over 5 minutes • Decrease insulin infusion rate by 50%, call MD and recheck blood glucose in 15 minutes • Ensure D5W IV infusion running
4–11.9 mmol/L	• Decrease insulin infusion rate by 50% • Call MD to reassess IV fluids and insulin • Ensure D5W IV infusion running
12–14 mmol/L (target)	• **Continue insulin infusion at current rate** • Ensure D5W IV infusion running
14.1–16 mmol/L	• If blood glucose is less than the previous test, no rate change • If blood glucose is the same or greater than the previous test, increase the rate by 0.5 units/hour
16.1–18 mmol/L	• If blood glucose is less than the previous test, no rate change • If blood glucose is the same or greater than the previous test, increase the rate by 1 unit/hour
18.1–20 mmol/L	• Increase infusion rate by 2 units/hour • If blood glucose is greater than 18.1 mmol/L for 3 consecutive q1h tests, call MD to reevaluate insulin infusion rate
Greater than 20 mmol/L	• Increase infusion rate by 3 units/hour and call MD

- **When changing patient from IV insulin to SC insulin, discontinue IV insulin 2 hours after the first dose of long-acting/premix SC insulin has been administered or 2 hours after SC insulin pump has been restarted.**
- Physicians to use SPO 215 when ready to change to SC insulin. If not on an insulin pump, a basal insulin is required for Type 1 diabetes and Type 2 diabetes on insulin at home.

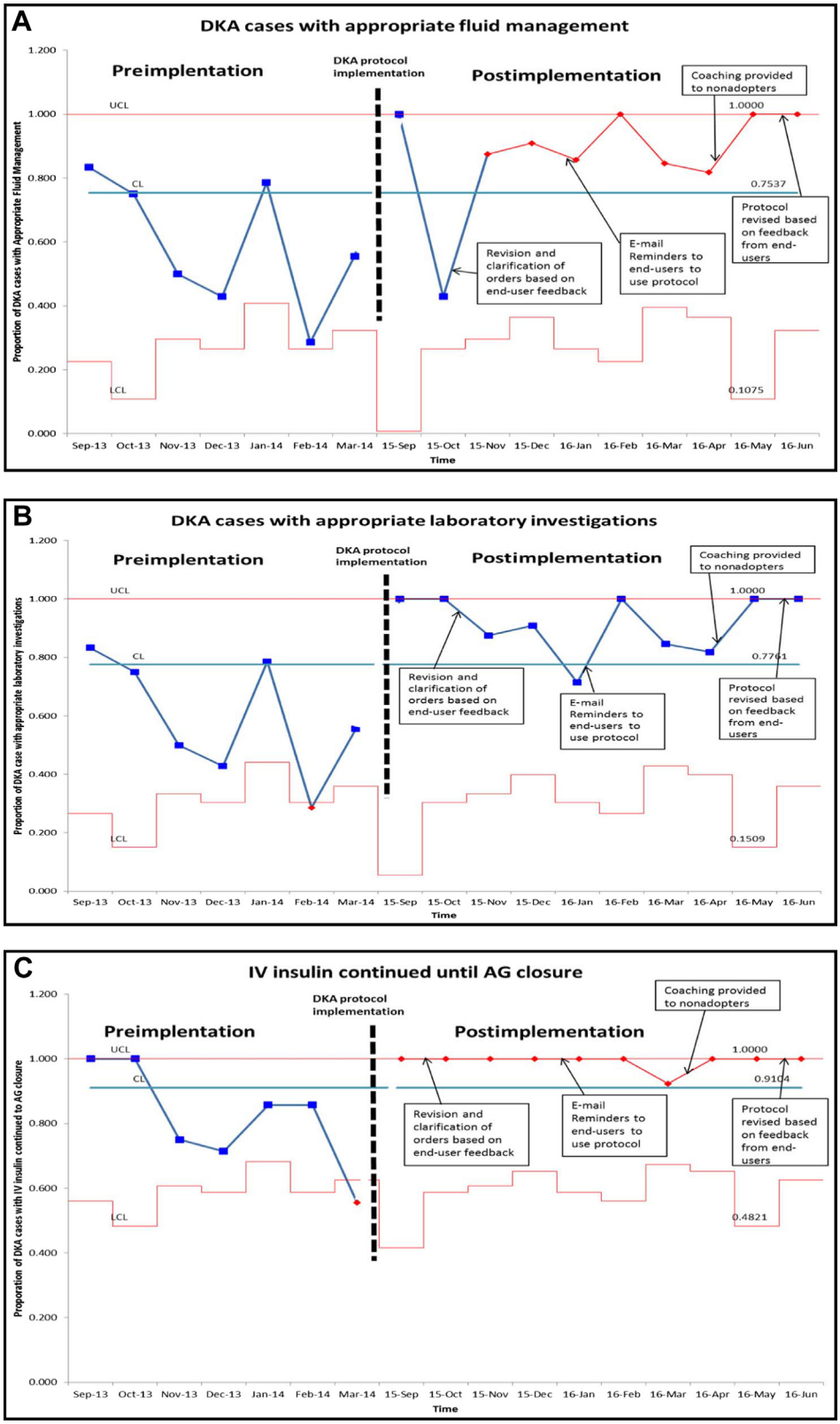
Date (yy/mm/dd)	Time	Physician (printed)	Signature (Physician)
Date (noted)	Time	Processed by	Signature (Nurse)

SPO 355 A (REV 04/2017) ER 1–Chart 2–Pharmacy 3–Nursing

Supplementary Figure 1. Preprinted order set for diabetic ketoacidosis for use in the emergency room of a multicampus tertiary care center.



Supplementary Figure 2. Plan, Do, Study, Act cycles.



Supplementary Figure 3. Clinical outcomes. A. Appropriate fluid management. B. Appropriate laboratory investigations. C. IV insulin continued to anion gap closure. AG, anion gap; *DKA*, diabetic ketoacidosis.